Appendix K

Evaluation of CDF Feasibility

Appendix K – Executive Summary

Appendix K presents and evaluates information to determine whether a confined disposal facility (CDF) in Slip 1 at Terminal 4 would meet the removal action objectives, including those for protectiveness in the short term and over the long term. The primary purpose of the CDF will be to protect human health and the environment by permanently containing the contaminated sediment dredged from the Removal Action Area.

The CDF will consist of three main parts: a berm (earthen wall) constructed near the mouth of Slip 1; the dredged sediment placed into the CDF; and a cap placed on top of the CDF after it is filled. The capacity of the CDF is estimated at 940,000 cubic yards (cy). Only about 12% of this capacity is needed to hold sediment from the Removal Action Area (approximately 115,000 cy of dredged material and 20,000 cy for an interim cap if needed). This leaves approximately 560,000 cy of excess capacity that will be used over time to hold other sediments from Portland Harbor The remaining capacity will require suitable fill before placement of the engineering cap and asphalt to finish the CDF at-grade with the surrounding land.

Appendix K examines five important questions related to the construction of the CDF, its potential impacts and the protectiveness it affords over the long term:

1. Will the CDF contain the sediments before, during, and after an earthquake?

2. Will there be long-term effects on the Willamette River from groundwater that passes through the CDF and then enters the river?

3. Will there be short-term effects on the Willamette River when sediment is being placed into the CDF?

4. How long it will take for sediment placed in the CDF to settle?

5. Will the CDF affect the Willamette River's flood stage?

The methods used to analyze these questions and the conclusions reached are summarized below.

CDF Will Withstand Earthquakes

One purpose of the CDF is to prevent contamination in the sediment from reaching the environment. To do that, the berm across the mouth of Slip 1 must remain stable under a variety of conditions. The following factors related to berm stability before, during, and after an earthquake were assessed:

- The characteristics of the sand that will underlie the CDF; this information is available from previous investigations.

- The standards that should be used in determining the amount of shaking the CDF can withstand. In this case, the CDF will be designed to withstand a moderate earthquake, which is called an "operating level event" (OLE), and a severe earthquake, which is called a "contingency level event" (CLE). The OLE is

an earthquake that causes minor damage to Port facilities (for example, repair of cracks in pavement) but does not prevent the facilities from operating; the CLE is a stronger earthquake that causes significant damage requiring major repairs (for example, reconstruction of collapsed buildings). These standards have been used to design and construct many other CDFs in the Pacific Northwest that have continued to function properly during and after earthquakes.

- The potential for sand below the CDF, which is saturated with water, to move during an earthquake, which was determined based on geotechnical tests performed at Slip 1.

- The stability of the berm's slope under three conditions: no earthquake, during an earthquake, and after an earthquake, which was computer-modeled using software that is the industry standard for this analysis.

- The strength of the soil used to build the berm.

Appendix K details the engineering and computer-modeling methods used to evaluate each of these factors and reaches the following conclusions about the CDF's stability:

- The berm will be stable in the absence of an earthquake.

- The berm will remain intact during and after an OLE-type earthquake, although minor repairs might be necessary. When such an event occurs, modeling predicts that the berm will likely move slightly (a few feet) and settle a bit. Contaminated sediment would not be released to the river.

- Contaminated sediments will remain in the CDF after a CLE-type earthquake. However, when a larger earthquake occurs, there likely would be considerable movement (many feet) of the berm and large settlement within and behind the berm. Damage to the berm would not cause contaminated sediment to be released to the river even in this larger earthquake. However, large portions of the berm could require repair.

CDF Will Meet Long-Term Water Quality Standards

After the CDF is constructed and filled, groundwater that passes through the CDF will enter the Willamette River. Therefore, it is important to know whether the groundwater is likely to pick up contamination as it passes through the CDF and then carry that contamination to the river. To understand how the groundwater will move, groundwater flow was computer-modeled using software approved by the regulatory agencies. To understand whether the groundwater will pick up contaminants in the sediment, tests were performed to learn which contaminants will release from the sediment into the groundwater, and computer modeling was performed to learn where those contaminants will be carried by the groundwater. Information about the local geology was also used in this analysis.

The leaching tests showed that six contaminants are likely to leach out of the sediment; four of the contaminants are metals (arsenic, cadmium, copper, and lead) and two of them are pesticides (chrysene and 4'4-DDE). The results of the computer modeling showed that at the inside edge of the berm (next to the buried sediment), the

amount of arsenic, copper, lead, and 4,4'-DDE in groundwater will be above the lowest standards for water quality set by the regulatory agencies. However, the computer modeling also showed that at the outside edge of the berm (next to the Willamette River), the amount of all six contaminants in groundwater will be below the lowest standards set by regulation. This happens because the soils used to construct the berm, as well as the existing soils surrounding the other sides of the CDF trap the low concentrations of the contaminants that leach from the sediments. Therefore, the contaminants picked up by groundwater as it passes through the CDF will not ultimately reach the Willamette River at levels above government standards and so they will not adversely affect the river over the long term. The berm and surrounding soils have the capacity to permanently trap more contaminants than will leach from the sediments.

CDF Will Meet Short-Term Water Quality Standards

During filling of the CDF, the water level in the CDF will rise, and water could flow out of the CDF and into the Willamette River; this is considered a short-term effect because it would only occur during filling. Any water that flows from the CDF into the Willamette River will contain some sediments, which need to be controlled to meet the regulatory standard for turbidity (cloudiness). Laboratory tests and a computer program developed by the U.S. Army Corps of Engineers and approved by regulatory agencies including EPA were used to assess possible short-term effects on the river.

Only about 12% of the CDF's capacity will be used to hold sediment dredged from the Removal Action Area. The analysis shows that there is enough room in the CDF to deposit that sediment without causing water to spill out. However, as more material is brought to the CDF from other sites and as the CDF nears capacity, it might be necessary to slow down the rate of dredging to allow enough time for the sediment to settle. In addition, certain well-established controls for turbidity, such as "silt curtains," will be used to contain any sediment that might flow out.

Time for Consolidation and Settlement Will Not Affect Performance

As layers of sediment are placed in the CDF, the material will compress under its own weight. The time it takes for the sediment to consolidate will determine when the land created by the cap placed on top of the CDF will be available for use, but does not affect the CDF's performance. Because of its particular characteristics, the sediment from Terminal 4 will likely consolidate relatively quickly. Fill material from other sources could take longer to consolidate; however, because the exact nature of the fill from other sources is unknown right now, it is not possible to predict how quickly that material will consolidate. Additional analysis will be required prior to acceptance of fill from other sources.

CDF Will Not Affect Willamette River's Flood Stage

Slip 1 is within the 100-year floodplain of the Willamette River. A computer model developed by the U.S. Army Corps of Engineers, and approved by EPA and the Federal Emergency Management Agency (FEMA), was used to assess whether flooding would be greater following CDF construction than it is today. The results indicate that the presence of a full CDF in Slip 1 will not increase the 100-year floodplain above the existing condition and there will be no noticeable impact to flooding in the Willamette River as a result of the CDF.

Conclusions

- Although a more severe CLE-type earthquake could cause substantial damage to the CDF berm, this damage will not result in the release of contaminated sediment. The CDF would be inspected, and, if necessary, repaired following an earthquake.

- Contaminants carried from the CDF in groundwater will be below levels of concern where the groundwater enters the Willamette River, causing no adverse impact.

- Short-term effects are unlikely during the initial CDF filling and can be controlled using well-established techniques, such as silt curtains.

- Terminal 4 sediment will consolidate relatively quickly. Sediment from other sites in Portland Harbor may have different characteristics that will have to be assessed prior to acceptance. Settlement rates will not affect the CDF's performance.

- The CDF will not increase the Willamette River's flood stage.

Based on this assessment, construction and operation of a CDF in Slip 1 is feasible as well as protective of human health and the environment.

Appendix K – Evaluation of CDF Feasibility

This appendix to the Terminal 4 Early Action engineering evaluation and cost analysis (EE/CA) report discusses the feasibility of an at-grade full-size confined disposal facility (CDF) in Slip 1. Preliminary analyses presented in this appendix were performed in general accordance with the U.S. Army Corps of Engineers' engineering and design manual for confined disposal of dredged material (USACE, 1987). Analyses were performed to assess the stability of the containment berm and impacts to long-term water quality. Additionally, short-term water quality and consolidation and settlement of the dredged fill are also assessed. Finally, the potential impacts of CDF construction on flood stage were assessed to determine whether CDF construction would raise the water surface elevation of the base flood within the Willamette River. Accordingly, Appendix K discusses the following topics:

- K.1 – CDF Configuration and General Assumptions;
- K.2 – Containment Berm Stability;
- K.3 – Long-Term Water Quality;
- K.4 – Short-Term Water Quality;
- K.5 – Consolidation and Settlement; and
- K.6 – Assessment of Potential Impacts on Willamette River Flood Stage.

K.1 CDF Configuration and General Assumptions

Preliminary analyses were performed to evaluate the feasibility of a CDF. This section presents general assumptions for the CDF feasibility assessment.

It was assumed that a full-size at-grade CDF will be constructed. The CDF will consist of three main components: (1) CDF containment berm, (2) dredged fill, and (3) CDF cap. The containment berm will be constructed near the mouth of Slip 1. Figure K-1 presents a typical cross section through the proposed CDF that illustrates its components. A preliminary assessment of the size of the CDF provided an estimated total volumetric capacity of approximately 940,000 cubic yards (cy) of fill, including approximately 695,000 cubic yards of contaminated dredged sediments and 245,000 cubic yards of other suitable fill material. The berm is assumed to consist of 2H:1V slopes with a 10-foot crest. The berm material will consist of a mix of sand and gravel. The berm will be constructed using training terraces consisting of quarry spalls or riprap (refer to Figure K-1), which will also serve as slope protection. A cap consisting of granular select fill and low-permeability asphalt will be placed on the fill material to minimize water infiltration.

K.2 Containment Berm Stability

This section presents a preliminary assessment of the stability of the CDF containment berm under static and seismic conditions. The CDF containment berm will serve as a retaining structure for the dredged sediments placed behind the berm. The containment berm will also serve as an isolation structure that acts as a barrier to physically isolate the solid-phase contaminants in the CDF from the environment. For the CDF to be feasible, the stability assessment of the containment berm needs to demonstrate that no contaminated sediments would be released into the water column under the design-level loading conditions.

K.2.1 Subsurface Conditions

Based on the results of the subsurface investigation presented in the Terminal 4 Early Action characterization report (BBL, 2004), Slip 1 is underlain by loose to medium-dense saturated alluvial sands to depths beyond 100 feet below the mudline. These sands are generally considered potentially liquefiable. The liquefaction potential of the alluvial sands is discussed in more detail below. Additional information on site geology and subsurface conditions is provided in Appendix C and the characterization report.

K.2.2 Seismic Design Criteria

The Terminal 4 Removal Action Area is in a seismically active region of the Pacific Northwest. Although there are currently no established requirements or guidelines regarding the appropriate design seismic events for CDFs, CDF containment berms designed in the Pacific Northwest and approved by USEPA Region 10 (e.g., the Thea Foss St. Paul Confined Disposal Facility) provide guidance for design. On the basis of designs that have received USEPA approval in the recent past, the following design seismic events were selected for this feasibility assessment:

- **Operating Level Event (OLE).** The operating level event represents an earthquake with a 50% probability of exceedance in 50 years (i.e., 72-year return period). Although waterfront facilities (including containment berms) may suffer minor damage during the OLE, they should generally still be operational.

- **Contingency Level Event (CLE):** The contingency level event represents an earthquake with a 10% probability of exceedance in 50 years (i.e., 475-year return period). During the CLE, waterfront facilities may suffer significant damage that would impair operations, and major repair work would likely be required, but no catastrophic failure should develop. Although design components such as a CDF containment berm may suffer substantial deformation, containment of the contaminated sediments should not be jeopardized.

A site-specific seismic response analysis was performed to estimate seismic parameters required as input for seismic slope stability and liquefaction analyses. The required parameters consisted of ground acceleration and cyclic stress ratio profiles. The seismic response analysis is presented in Appendix C of the EE/CA report.

K.2.3 Liquefaction Potential

The Removal Action Area is underlain by deep, loose to medium-dense alluvial sands in a saturated condition. This type of material is typically prone to liquefaction. Liquefaction is caused by excess porewater pressures induced by cyclic loading (e.g., strong seismic shaking). The excess pore pressures generated during seismic shaking result in a reduction of effective stress, thereby reducing the strength of the soil. Preliminary liquefaction analyses were performed based on results of the standard penetration test (SPT) using the "simplified procedure" presented in Youd et al. (2001). The SPT data were obtained from borings GEO1W and GEO2W. Cyclic stress ratios were obtained from the site-specific response analysis to calculate factors of safety against liquefaction. Liquefaction analyses were performed for several locations between the toe of the berm and the crest of the berm, as shown on Figure K-2.

The results of the preliminary liquefaction analyses showed that liquefaction occurs within the alluvial sands under the OLE and under the CLE. Residual shear strengths were estimated for the liquefied soils using a correlation with SPT results presented in Idriss (1998). For the CLE, the analyses showed that liquefaction would extend under the CDF berm slope that faces the water. For the OLE, liquefaction would not extend as far under the berm. No liquefaction was indicated under the crest of the containment berm for either the CLE or OLE. It is assumed that liquefaction-induced deformations at the toe of the berm are possible after the OLE. However, these deformations, which should be repaired following the OLE, should not immediately affect Port operations. More substantial deformations of the berm are expected due to liquefaction under the CLE. The assumptions for the extent of liquefaction during the OLE and the CLE are illustrated on Figure K-2.

Analyses of the post-earthquake slope stability of the CDF berm under the CLE are presented in the following sections.

K.2.4 Methods of Stability Analysis

Preliminary slope stability analyses were performed for the CDF containment berm using the limit-equilibrium computer program Slope/W. Factors of safety were calculated based on the Spencer method of slices for three cases:

- **Long-term static stability.** This case represents conditions after completion of the CDF. Drained strength parameters were used to calculate factors of safety for the long-term static case.

- **Pseudostatic stability.** This case represents conditions during the design seismic event. Undrained strength parameters were used for cohesive soils or potentially cohesive soils such as the dredged fill contained by the berm. Drained parameters were used for granular material such as the berm material and the foundation soils. A seismic coefficient was applied to represent the forces during seismic shaking. The seismic coefficient was estimated based on the peak accelerations within the containment berm (refer to the site-response analysis in Appendix C). The seismic coefficient was determined as one-half of the average acceleration within the berm as outlined in the Federal Highway Administration's Geotechnical Earthquake Engineering Reference Manual (FHWA, 1998). For the CLE, a seismic coefficient of 0.1 g (g = acceleration of gravity) was used. The coefficient calculated based on the site-response analysis was smaller, but the minimum coefficient used in North America is typically 0.1 g (FHWA, 1998). For the OLE, a smaller coefficient of 0.05 g was used to reflect the smaller seismic response during that event.

- **Post-earthquake stability.** This case represents conditions just after a design-level seismic event when portions of the foundation soils are in a liquefied state. Residual shear strengths were assigned to the soils in a liquefied state under the design-level event.

K.2.5 Soil Properties

The soil properties used in the berm stability analyses consisted of shear strength parameters and soil unit weight. The soil properties are presented on Figures K-3 through K-5. These properties were obtained based on test results, correlations provided in the literature, and experience with similar soils. The strength parameters were estimated for drained and undrained conditions, as well as liquefied conditions (i.e., residual strength):

- **Drained strength.** Drained strength parameters were generally used for the long-term static case where there is sufficient time for pore pressures to dissipate. They were also used for granular soils for the pseudostatic case and for non-liquefiable soils for the post-earthquake case. The drained strength parameters consisted of angles of internal friction (or friction angles). The friction angles of the foundation soils (i.e., alluvial sands) were based on corrected SPT blow counts (i.e., $(N_1)_{60}$ values) (Terzaghi et al., 1996). The parameters for other soils (e.g., berm and cap material, as well as dredged fill) were estimated based on their predicted densities and composition.

- **Undrained strength.** Undrained strength parameters were used for soils that would exhibit undrained behavior under quick loading conditions such as seismic loading (i.e., pseudostatic case). Undrained strength was used only for the dredged fill, assuming that material would be cohesive in nature. Other soils in the vicinity of the berm are assumed to be granular in nature and would exhibit drained behavior.

- **Residual strength.** Residual strength parameters consisting of equivalent undrained strength values were used for liquefiable soils in the post-earthquake analysis. It is assumed that portions of the alluvial sands underlying the site liquefy under the design seismic event (refer to Section K.2.3). Residual strength values were estimated using a correlation with corrected SPT blow counts developed by Idriss (1998).

K.2.6 Results of Slope Stability Analyses

The results of the slope stability analyses are presented in the following sections.

K.2.6.1 Long-Term Static Stability

The minimum factor of safety for the long-term static stability of the berm is approximately 1.2 and corresponds to a relatively shallow slip surface that extends up to the crest of the berm. Figure K-3 presents the results of the long-term static stability analyses and shows potential slip surfaces with corresponding factors of safety. The factor of safety for deeper slip surfaces that extend from behind the berm through the foundation soils and beyond the toe of the berm is approximately 1.5.

K.2.6.2 Pseudostatic Stability

Factors of safety for the pseudostatic case were determined for the CLE and OLE:

- **CLE.** A pseudostatic coefficient of 0.1 g was used for the CLE. As outlined in Section K.2.4, this coefficient is slightly greater than half of the average maximum acceleration within the containment berm. The minimum factor of safety is approximately 1.0 and corresponds to a relatively shallow slip surface that extends up to the crest of the berm. Figure K-4 presents the results of the pseudostatic stability analyses and shows the approximate location of the slip surface that corresponds to a factor of safety of 1.0. Based on research performed by Hynes and Franklin (1984), a factor of safety of 1.0 in conjunction with a seismic coefficient of half the maximum acceleration generally limits deformations to less than 1 foot. Therefore, it is assumed that there is a potential for permanent deformations along

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the surface of the slope, but maximum deformations along the slip surface will likely not exceed 1 foot. Factors of safety for deeper surfaces are greater than 1.0. Based on the slope stability results, it is assumed that sliding would likely occur along relatively shallow slip surfaces similar to the one shown on Figure K-4.

- **OLE.** A pseudostatic coefficient of 0.05 g was used for the OLE. The minimum factor of safety is approximately 1.1 and corresponds to a relatively shallow slip surface that extends up to the crest of the berm (similar to the one for the CLE). Figure K-4 presents the results of the pseudostatic stability analyses and shows the approximate location of the slip surface that corresponds to a factor of safety of 1.1. Factors of safety above 1.0 generally indicate that permanent deformations should be relatively small. It is assumed that only minor repairs may be required following an earthquake of this magnitude.

K.2.6.3 Post-Earthquake Stability

Post-earthquake slope stability analyses were performed for the CLE and the OLE. The difference between the two events is the extent of liquefaction under the berm, as outlined in Section K.2.3. The following factors of safety were calculated for the CLE and the OLE:

- **CLE.** The minimum factor of safety for the CLE post-earthquake case is less than 1.0 and corresponds to a slip surface that intersects the liquefiable soils below the berm and extends just behind the crest of the berm. Larger and deeper slip surfaces with marginal factors of safety are possible, as indicated on Figure K-5 (slip surface B). Based on these results, substantial deformations of the berm may occur under the CLE.

- **OLE.** The minimum factor of safety for the OLE post-earthquake case is approximately 1.0 and corresponds to a slip surface within the face of the berm. The results of the analysis and the approximate location of the slip surface are presented on Figure K-5.

K.2.7 Discussion of Stability Results and Conclusions

Based on the slope stability results presented above, the containment berm is stable under static conditions. Although the minimum factor of safety (FS) for static conditions is relatively low (i.e., FS = 1.2), similar containment berms constructed in the Pacific Northwest (e.g., Hylebos Slip 1, Thea Foss, Eagle Harbor, and Sitcum Waterway) have not experienced failure or excessive deformations. Additionally, it is assumed that the berm would be constructed with training terraces consisting of riprap at and near the face of the berm. This was not modeled in the analyses and would further improve stability, particularly the stability of the face of the berm.

The stability of the berm during and following strong seismic shaking was modeled for the OLE and the CLE. While some limited deformations may be possible during and after the OLE, the results indicate that the berm would generally remain intact, containment of sediment would be maintained, and Port operations would not be impaired immediately. However, relatively minor repairs along the slope face of the berm might be necessary after the OLE.

The stability results for the CLE indicate that large deformations of the berm may occur due to liquefaction of the loose to medium-dense alluvial sands that underlie the berm. Although deformations may be significant, a release of contaminants is unlikely because the materials in the berm, the cap and in the CDF fill, being largely similar in nature (saturated, granular soils), will deform in a relatively compatible manner, without developing a rupture through which contaminated sediments may escape.

If large deformations were to occur, potentially large portions of the berm would have to be repaired.

K.3 Long-Term Water Quality

Numerical groundwater flow and solute transport modeling was performed to assess potential water quality impacts of the proposed CDF on the Willamette River. The model was used (1) to evaluate the transport of chemicals of potential concern (COPCs) contained in sediments that would be placed into the CDF and (2) to estimate groundwater concentrations for the COPCs at the outside edge of the CDF berm adjacent to the river. This type of modeling has been effective at evaluating the feasibility of a CDF at other Northwest sites (Boatman and Hotchkiss, 1997).

The modeling procedure consisted of two distinct components: development of a groundwater flow model for the CDF and development of a contaminant transport model. The CDF groundwater flow modeling was performed using MODFLOW (McDonald and Harbaugh, 1988) and the graphic user interface Groundwater Vistas (Environmental Simulations International, 2004). The solute transport modeling was performed using MT3D (Zheng and Wang, 1999).

K.3.1 Local Hydrogeologic Conditions

The hydrogeology of Terminal 4 is summarized in Appendix D of the EE/CA report and presented in greater detail in the Terminal 4 characterization report (BBL, 2004).

Generally, the geologic stratigraphy adjacent to and beneath the proposed CDF consists of the following geologic units:

- the upland fill material, consisting of medium to fine sand ranging in thickness from about 5 to 40 feet.
- the Unconsolidated Alluvial Deposits, consisting of fine sand west of the former shoreline and interbedded layers of gravel, sand, silt, and clay to the east of the former shoreline ranging in thickness from 120 to 160 feet; and
- the Troutdale Gravel, encountered at an elevation of approximately -114 to -168 feet Columbia River Datum (CRD).

West of the former shoreline, the upland fill material and Unconsolidated Alluvial Deposits form a single hydrostratigraphic unit. East of the former shoreline, the finer-grained materials restrict groundwater flow from the upland fill material and act as a confining layer for the Troutdale Gravel beneath.

Groundwater horizontal hydraulic gradient and implied flow direction are toward the Willamette River. In nearshore locations, groundwater in the upland fill material, Unconsolidated Alluvial Deposits, and Troutdale

Gravel is in direct hydraulic connection with the river, and groundwater elevations respond rapidly to changes in river stage.

K.3.2 TCLT Data

This section presents an evaluation of long-term water quality for the CDF based on data presented in Appendix F. Appendix E describes how total values were calculated.

The thin-column leaching test (TCLT) was performed to determine potential long-term water quality impacts from the CDF (described below). For the purpose of the CDF feasibility evaluation, the TCLT results were used to identify chemicals of potential concern (COPCs) that were retained for the transport analysis described in Section K.3.3. COPCs were identified as those that exceeded the criteria presented below. One composite sediment sample (T4-CM2) made up of material from Wheeler Bay, Slip 3, and north of Berth 414 was analyzed for the anaerobic TCLT. Deionized water was used as the leachant. The TCLT chemistry results are compared to federal and Oregon state surface water criteria in Tables K-1 and K-2, respectively.

The federal surface freshwater quality criteria (40 Code of Federal Regulations 131.36) to which the data are compared in Table K-1 are:

- the maximum criteria;
- the continuous criteria; and
- the consumption of water and organisms criteria.

The Oregon state surface freshwater quality criteria (Oregon Administrative Rules 340-041-033) to which the data are compared in Table K-2 are:

- the acute criteria;
- the chronic criteria; and
- the water and fish ingestion criteria.

These criteria were used as a conservative guide to evaluate potential long-term water quality impacts from a CDF; however, the use of these criteria does not imply that they should be or would be used as water quality criteria for a CDF in the Removal Action Area. The comparison of TCLT data to surface water criteria is a conservative approach. The TCLT leachate acts as a laboratory-scale model of peak leachate concentrations from dredged material deposited in a CDF. The TCLT leachate represents leachate in the CDF, not at the point of compliance (the river). TCLT leachate concentrations above surface water criteria do not indicate that there would be concentrations above the surface water criteria at the point of compliance. Rather, it indicates that these COPCs should be further evaluated by groundwater modeling to evaluate concentrations at the point of compliance. Groundwater modeling was performed to evaluate COPC concentrations at the point of compliance and is presented in Section K.3.3. A number of water quality criteria (including those for mercury and some PAHs, pesticides, and PCBs) are below the practical quantitation limits that can be achieved by an analytical laboratory. This results in the detection limit being higher than the water quality criterion. These constituents were not modeled specifically but are expected to behave similarly to other compounds in that class of constituents that were modeled. Groundwater modeling indicates COPC concentrations will be below surface water criteria at the CDF/river boundary. The data are adequate to evaluate the feasibility of a CDF.

TCLT data are sometimes discussed in terms of exceedance ratios, terminology that is used in this report. An exceedance ratio is derived by dividing the TCLT concentration of an analyte by the corresponding water quality criterion. An exceedance ratio of greater than 1 indicates a concentration that exceeds the criterion.

Arsenic was detected in all the TCLT samples at concentrations above the federal consumption of water and organisms criterion and the Oregon state water and fish ingestion criterion. Concentrations of cadmium were above the Oregon state chronic criterion in most of the TCLT samples. Copper and lead were detected in all the TCLT samples at concentrations above the federal and Oregon state water quality criteria. Figure K-6 presents TCLT metals concentrations over time.

Individual polycyclic aromatic hydrocarbon (PAH) compounds were detected at concentrations below the water quality criteria with the exception of chrysene in one TCLT sample (T4-CM2-16), which was detected at a concentration above the federal consumption of water and organisms criterion and Oregon state water and fish ingestion criterion. Total PAH concentrations in most of the TCLT samples were above the Oregon state water and fish ingestion criterion. Figure K-7 presents TCLT total PAH concentrations over time.

The pesticide 4,4'-DDE was detected above the Oregon state water and fish ingestion criterion. Two detected concentrations of Σ DDTs were above the Oregon state chronic criterion. Detected total polychlorinated biphenyls (PCBs) were below the water quality criteria. Figures K-8 and K-9 present total DDT (as a surrogate for Σ DDTs, because more water quality criteria are available for total DDT) and total PCB concentrations over time, respectively.

All individual constituents that exceeded the minimum applicable criterion for that constituent were retained for transport analysis. The constituents retained for further analysis included arsenic, cadmium, copper, lead, chrysene, and 4,4'-DDE. The analyses conducted included numerical modeling evaluations of the potential transport of these constituents from a CDF (described below).

K.3.3 Conceptual Model and MODFLOW Model Construction

The following summary of subsurface stratigraphy is based on existing geotechnical borehole data from BBL (2004). Generally, the stratigraphy of Slip 1 sediments (Unconsolidated Alluvial Deposits) in the vicinity of the CDF footprint consists of sand, silty sand, and sandy silt in the portion of the CDF closest to the head of the slip and fine sand in the portion of the CDF farthest from the head of the slip (Figure K-1).

The conceptual model for the Terminal 4 Slip 1 CDF consists of a generalized two-dimensional (2-D) east-west cross section through the CDF structure. The generalized cross section combines different elements of the CDF structure, including the sediment stratigraphy and the containment berm and cap. Upland groundwater to the east of the CDF and the Willamette River to the west of the CDF were considered to be the boundaries of the model. The key hydrologic units identified for inclusion in the model were:

- CDF containment berm constructed from well-sorted gravel and sand;
- CDF infill sediments;
- CDF cap constructed from sand; and
- Unconsolidated Alluvial Deposits beneath the CDF.

The above units are presented schematically in Figure K-1, which illustrates the basis for the 2-D model. It has been assumed that groundwater flow within the CDF will be driven by hydraulic gradients that result from groundwater flowing from the uplands through the CDF, as well as any water that has infiltrated through the CDF cap.

The model was simulated for steady-state conditions (i.e., long-term static hydraulic head distribution), since the major objective was to estimate long-term (>5 years) COPC migration. Fluctuations of Willamette River levels adjacent to the CDF are not expected to significantly alter the steady-state direction and velocity of groundwater flow through the CDF and were not included in this model. In addition, vertical groundwater flow was not considered in this model.

K. 3.3.1 Groundwater Flow Model

A modular three-dimensional finite-difference groundwater flow model (MODFLOW) was used to simulate the flow of water within the CDF structure. MODFLOW is a groundwater flow simulator that is well accepted by regulatory agencies and widely used for a variety of applications. It enables the modeler to simulate both steady-state and transient-state flow regimes in both two- and three-dimensional space. A detailed description of MODFLOW is provided in the users' manual (McDonald and Harbaugh, 1988).

Model Domain

The grid for the numerical finite-difference flow model consisted of 450 rows, two columns, and 50 layers. Horizontal grid spacing varied from 2 feet from the upland shore to the containment berm. The vertical discretization was performed based on the conceptual model as described above. The top layer of the model corresponds to elevation 31.5 feet CRD, which is the assumed top-of-CDF-cap elevation (Table K-3 and Figure K-1). The bottom of the CDF (i.e., the top of the underlying Unconsolidated Alluvial Deposits) corresponds to an elevation of -35 feet CRD. The estimated average water level within the CDF after CDF construction is at approximately elevation +10 feet CRD. Terminal 4 sediments will fill the CDF to approximately elevation -25 feet CRD. Although it is expected that sediments will be filled up to the estimated water table within the CDF, the model uses a top-of-fill elevation of +1.5 feet CRD, which is above the fill elevation for Terminal 4 sediments and therefore is a conservative assumption at this point. The chemical composition of material that will be placed above elevation -25 feet (i.e., above the Terminal 4 sediments within the CDF) is not known at this time. Additional groundwater flow modeling is recommended once the chemical composition of dredged sediments from sources outside of Terminal 4 is known.

Groundwater Flow Boundary Conditions

Boundary conditions are values or solutions to equations that are specified along the perimeter of the modeling domain. Boundary conditions are assigned to account for the interaction between the groundwater flow within the model domain and the rest of the system. For the groundwater flow model, the boundary conditions are related to the hydraulic head distribution in the vicinity of the model domain boundary. Groundwater elevation and Willamette River stage data from the Terminal 4 characterization report (BBL, 2004) were used to define the boundary conditions for the groundwater flow model.

A groundwater hydraulic head value of 14 feet CRD was specified for the eastern edge of the CDF along the head of Slip 1 (Table K-3 and Figure K-1). A Willamette River hydraulic head value of 5 feet CRD was specified for the western edge of the CDF. A "no-flow" condition was specified along the eastern and western boundaries of the modeling domain, since these boundaries were constructed to be parallel to the interpreted groundwater flow direction.

Groundwater Flow Parameters

Hydraulic conductivity, porosity, and bulk density values initially assigned to different portions of the CDF structure and existing sediment stratigraphy were based on site-specific field and laboratory data where possible or otherwise estimated from published acceptable ranges (Table K-3). The horizontal hydraulic gradient of 0.01 foot/foot for groundwater was based on the average horizontal hydraulic gradient estimated for shallow and intermediate depth groundwater during April and May 2004 (BBL, 2004).

Recharge through the CDF cap is a function of annual precipitation, evaporation, transpiration through vegetation, ground slope, and grain size of the soils. Man-made surface structures, such as roads, pavement, buildings, and drainage systems also affect recharge. Using the Hydrologic Evaluation of Landfill Performance (HELP) model (Schroeder et al., 1994), groundwater recharge rates through the CDF cap were estimated at 22.3 and 0.92 in/year for unpaved and paved conditions, respectively. These recharge rates provided the initial recharge values for the model.

K.3.3.2 Solute Transport Model

Site-specific COPC solute transport models were developed for six COPCs:

- arsenic (As);
- cadmium (Cd);
- copper (Cu);
- lead (Pb);
- Chrysene; and
- 4,4'-DDE.

As described in Section K.3.2., these constituents had TCLT leachate concentrations that exceeded the minimum applicable water quality criteria (Table K-4). The initial sediment porewater concentration of these COPCs for the prediction of solute transport was set to the maximum concentration measured during the TCLT study (Table K-4). The initial upland groundwater concentration for these constituents was set to the maximum measured concentration in groundwater collected from temporary well points and monitoring wells located at the head of Slip 1 (Hart Crowser, 2004).

COPCs in CDF sediments and porewater are subject to a variety of physicochemical processes, including advective, dispersive, and diffusive transport, as well as adsorption to sediment particles, biodegradation, and other mechanisms that may occur during transport. These processes may have a significant effect on COPC concentrations in groundwater, and on a COPC's ultimate travel time to a given point. COPCs in groundwater may move at a slower rate than the groundwater due to the adsorption of the compounds to sediment particles.

This process is described as retardation of a given compound in the groundwater. The retardation factor varies for different compounds and for different sediment organic carbon contents.

Sorption refers to the chemical transport process whereby chemicals, such as metals dissolved in groundwater, partition preferentially to solid-phase aquifer materials. The quantity of a chemical that can partition to solid-phase materials is directly proportional to the affinity of the dissolved chemical to sorb to the solid-phase material. This affinity is described by the soil-water partition coefficient, K_d. The result of this process is that some quantity of the chemical mass is removed from groundwater during transport, and the rate of COPC migration in groundwater can be less than the average linear groundwater velocity.

To more accurately evaluate the role that sorption plays in retarding the COPC plume migration rate relative to the average linear groundwater velocity in CDF sediments, COPC-specific retardation factors can be estimated based on the following equation (Freeze and Cherry, 1979):

$$R_c = 1 + [\rho_b \; x \; K_d \, / \, n]$$

where R_c is the retardation factor for a specific chemical (c), ρ_b is the bulk density of the soil, K_d is the chemical-specific soil-water partition coefficient, and n is the soil porosity. For organic COPCs, K_d can be described by $K_{oc} \times f_{oc}$ where K_{oc} is the chemical-organic carbon partition coefficient and f_{oc} is the fraction of organic carbon in the soil.

Site-specific K_d values were developed from the TCLT results described in Section K.3.2 by dividing the sediment sample COPC concentration by the TCLT COPC eluent concentration. Values for K_d for the six COPCs and K_{oc} for chrysene and 4,4'-DDE are provided in Table K-4. f_{oc} values for the aquifer material and various components of the CDF are provided in Table K-3. Because the estimated site-specific K_d and K_{oc} values for 4,4'-DDE were based on a single J-qualified concentration and non-detect values, and the estimated site-specific K_{oc} values were orders of magnitude lower than published literature values, a K_{oc} value of 155,000 L/kg was used for modeling purposes (Fetter, 1994).

Field-scale longitudinal dispersivity reflects the deviation of the solute in groundwater from the main flow path due to local small-scale variations in the groundwater velocity. As a "rule of thumb," longitudinal dispersivity is often assumed to be between 3% and 10% of the COPC travel distance (e.g., Gelhar et al., 1992). The distance from the head of Slip 1 to the inside edge of the berm is approximately 600 feet. Therefore, longitudinal dispersivity is expected to range from 18 to 60 feet (Table K-3). Transverse dispersivity is typically assumed to be between 10% and 30% of the longitudinal dispersivity value, and vertical dispersivity is typically assumed to be between 10% and 30% of transverse dispersivity.

Degradation of organic compounds may be described as the transformation of a compound from one form to another. The final form may be a structurally different compound or complete mineralization into carbon dioxide, water, oxygen, and other inorganic matter. For this initial CDF modeling effort, degradation of organic COPCs was assumed to be zero.

Predictive Simulation Results

For the Base Case Scenario, the model was run using conservative model input parameter values assuming sandy infill sediment material, as shown in Table K-5. As shown in Table K-6, model results indicate that predicted COPC concentrations in groundwater at the inside edge of the berm (adjacent to the fill material) exceed the minimum applicable criteria for arsenic, copper, lead, and 4,4-DDE. However, groundwater concentrations at the outside edge of the berm (adjacent to the Willamette River) were below minimum applicable criteria for all six COPCs. Because model input parameter values were conservative, the model results are also conservative. Therefore, as modeled under expected CDF design and operation conditions, transport of COPCs from the CDF will not adversely impact surface water quality.

K.4 Short-Term Water Quality

Following construction of the containment berm, the CDF will be filled with dredged sediments. If filling progresses at a relatively fast rate, the water level within the CDF will rise. If water rises high enough, it will be discharged over a weir and into the river. During dredging, the water within the CDF will contain some suspended sediments. The total suspended solids (TSS) concentration in the water that goes over the weir needs be controlled so that water quality standards are met. The TSS concentration at the weir is influenced by several factors, including filling or dredge production rate, solids concentration of influent, size of CDF and ponding depth, and sediment settling characteristics. The allowable concentrations at the weir are estimated based on the results of the modified elutriate test (MET).

The volume of material that will be dredged at Terminal 4 (for Alternative C, the alternative that includes the CDF) is estimated to be approximately 115,000 cy, which is only about 11% to 12% of the total volume capacity of the CDF. Initial modeling of effluent characteristics at the weir using SETTLE, a program developed by the U.S. Army Corps of Engineers, and results of the column settling test (CST) was performed. The ponding depth during initial filling will be large, and preliminary analyses indicate that short-term water quality will not be affected even at high dredge production rates (i.e., greater than 8,000 cy per day). MET results (Appendix F) suggest there may be water quality impacts from water discharging at the weir. However, the MET used a 24-hour settling time. Given the small volume of Removal Action sediment in comparison to the total volume capacity of the CDF, settling times would likely be longer and, therefore, there would likely not be short-term water quality impacts. As additional material is brought in from sites outside of Terminal 4 and as the fill in the CDF approaches capacity, the dredge production rate may have to be reduced to meet water quality standards. Appropriate production rates will have to be determined once potential fill material has been identified. Additional analyses will be performed based on the characteristics of the sediments, which will be determined based on testing of representative samples. Alternatively, comparing fill physical properties (e.g., gradation and plasticity) to the sediment used in the CST may suffice in lieu of testing if the sediments are similar.

K.5 Consolidation and Settlement

Once the dredged material has settled out of the water column onto the bottom of the CDF and as additional material is placed on top of existing fill, the material will compress under its own weight. If the material has a high fines content and its permeability is relatively low, self-weight compression can take a significant amount

of time. This time-dependent settlement process is referred to as consolidation. The time it takes for the material to consolidate determines when the land gained by constructing the CDF becomes available for use.

Only about 12% to 13% of the material to be filled in the CDF will consist of Removal Action sediments from Terminal 4. The compositional characteristics of the Terminal 4 material indicate that consolidation would occur relatively quickly. However, material from other sources may take longer to consolidate. The other sources and the characteristics of those materials have not been identified, and it would be impracticable to attempt to assess the consolidation behavior of that material. However, the consolidation characteristics of the Terminal 4 sediments will not affect the overall feasibility of the CDF.

K.6 Assessment of Potential Impacts on Willamette River Flood Stage and Flood Storage

Slip 1 of Terminal 4 is within the mapped 100-year floodplain (Zone AE) of the Flood Insurance Rate Map (FIRM) 4101830060E, revised October, 19, 2004. The potential impact of CDF construction on the water surface elevation of the 100-year flood within the Willamette River and floodplain was assessed to evaluate compliance with the Executive Order for Floodplain Management (Executive Order 11988), USEPA implementing regulations, and the Federal Emergency Management Agency (FEMA) regulations.

Pursuant to the FEMA regulations, no increase in the base flood elevation can result due to placement of fill or placement of structures within a floodway. Consequently, if the CDF is placed within the floodway boundary, this would require an analysis to demonstrate that the encroachment into the floodway will not increase the base flood elevation. Although the proposed CDF in Slip 1 does not encroach within the floodway, an analysis was performed to assure that the CDF would not cause a rise in the base flood elevations. The assessment was conducted by using the USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) to model 100-year floodplain and floodway elevations for the Willamette River near Terminal 4 under existing conditions and with the construction of a full CDF in Slip 1. The proposed caps associated with Alternative C were also included in the analysis to ensure a comprehensive analysis of the potential impacts of the CDF alternative. A detailed description of the modeling procedures and results are provided in Attachment K-1 to this appendix.

The 1979 HEC-2 computer model, used in the effective FEMA's Flood Insurance Study for the area, and available bathymetry data provided by the Port were used as the basis for the modeling effort. First, an "existing condition" model was developed using HEC-RAS. The existing condition model was more detailed than the 1979 HEC-2 model, including additional cross sections detailing the Terminal 4 slips. Once the existing condition model was completed and checked, a "revised condition" model was constructed by incorporating preliminary design parameters for the full CDF (and caps) into the existing condition model. Results from the revised condition model were then compared to the existing condition to estimate the potential impact of the full CDF on flood stage elevations. The modeling results indicate that construction of a full CDF in Slip 1 would not increase the existing 100-year floodway or floodplain elevations at any location relative to the existing condition.

An analysis of flood storage impacts was also conducted to ensure that the removal action will not increase flood hazards to downstream property owners. Flood storage refers to the temporary filling of overflow areas or retention/delay of runoff during a flood event. The water that is spilled into the overbank areas during a storm event is temporarily stored, thus reducing the quantity of flow downstream in the main channel of the stream. As the flood recedes, the overland areas drain back in the stream. The area available for flood storage is the area

above the stream level just preceding the storm event, termed the non-storm winter stage, up to the 100-year flood elevation.

A portion of the CDF will be located above the non-storm winter stage and some flood storage will be lost by placement of the CDF. The volume of flood storage provided by Slip 1 was calculated based on a digital terrain model of the site from bathymetry and topographic information. The fill time was calculated based on the 100-year discharge for the Willamette River at T-4 of 375,000 cubic feet per second (cfs). The analysis demonstrates that the lost flood storage from filling Slip 1 has an insignificant effect in reducing flood hazard due to the relative size of the Columbia and Willamette River drainage basins, the location of Terminal 4 on the Willamette river, the amount of storage provided by Slip 1 relative to the drainage basin, the duration of the flood events on the Willamette River and the riverine hydraulics. Based on the analysis, Slip 1 provides insignificant effective flood storage at this location on the Willamette River and the loss of flood storage from the CDF would not have a noticeable impact downstream. A detailed description of the flood storage analysis is provided in Attachment K-2 to this appendix.

K.7 Summary

As presented above, the key design issues affecting the overall feasibility of a CDF were evaluated. Those issues and the findings are summarized below:

- **Overall Structural Strength and Stability of the CDF Berm:** The evaluations support that the CDF can be designed and constructed to meet the structural strength and stability requirements for the Portland area. Because Portland is in a seismically active area, the impact of seismic events on structures, especially those founded on saturated, loose soils such as sediments, needs special consideration. Preliminary analyses indicate that liquefaction occurs within the foundation soils below the berm and within the dredged fill, under the seismic design events (OLE and CLE). This liquefaction may cause excessive settlement under the containment berm and thus the berm could potentially experience relatively large deformations. It is not expected that the berm deformation would lead to release of contaminated sediment. The CDF would have to be inspected following seismic events and any damage to the CDF berm or CDF cap would have to be repaired.

- **Short-Term Water Quality Impacts.** Water quality criteria will be established for the construction period of the CDF and will be met by employing well-established control mechanisms (e.g., silt curtains, turbidity curtains). The CDF may be filled with sediment delivered in slurry form, if hydraulic dredging is used, or by double handling the material over the berm, or hydraulic transport if mechanical dredging is used in Slip 3. Numerous resuspension containment techniques are available, including controlled placement of the sediment and various containment structures, such as silt curtains and turbidity curtains, for use in meeting water quality criteria set for the construction period of the CDF.

- **Long-Term Water Quality Impacts.** Preliminary fate and transport analyses showed that water quality would meet the criteria for existing long-term water quality standards. Based on groundwater modeling, the containment berm provides sufficient isolation and buffering to retard migration of liquid-phase contaminants so that concentrations of the contaminant at the CDF/river boundary (the compliance point) will be below surface water criteria.

- **Consolidation and Settlement.** The CDF can be designed and managed to control affects of consolidation and settlement. Because of the relatively high sand content of the Terminal 4 sediments to be placed in the CDF, consolidation will occur relatively quickly and is not expected to cause construction delays. The CDF may receive other sediment from contaminated sediment management or navigational dredging projects, and those sediments may exhibit different settlement and consolidation characteristics. The schedule and rate of placement may have to be adjusted to accommodate settlement characteristics of sediment placed in the CDF. Design and placement of the final cap over the CDF can be implemented to allow for long-term settlement in the CDF.

- **Potential Impacts on Willamette River Flood Stage and Flood Storage.** The preliminary assessment of potential impacts to the Willamette River showed that the rise in flood stage would be negligible and would meet federal criteria. The preliminary assessment of flood storage impacts showed that the loss of flood storage at Terminal 4 would not increase peak discharge downstream and no noticeable impact to flooding in the Willamette River would occur as a result of the CDF.

The evaluations for construction of a CDF in the Removal Action Area support that it is a feasible element of the removal action.

K.8 References

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Table K-1
TCLT Leachate Chemistry Results Compared to Federal Surface Water Quality Criteria

Sample ID: Lab ID: Date Sampled:	Maximum Criteria	Continuous Criteria	Consumption of Water and Organisms Criteria	T4-CM2-1 K2402978-006 04/07/2004	T4-CM2-2 K2402978-007 04/20/2004	T4 CM2-3 K2403293-001 05/02/2004	T4CM2-4 K2403459-001 05/08/2004	T4-CM2-5 K2403657-001 05/14/2004	T4 CM2-6 K2403768-001 05/19/2004
Metals (ug/L)									
Arsenic	360	190	0.018	NA	NA	3.2	NA	NA	2.4
Cadmium	0.82	0.37	NA	NA	NA	0.21	NA	NA	0.07
Chromium	180	57	NA	NA	NA	4.3	NA	NA	3.21
Copper	4.6	3.5	NA	NA	NA	**3.81** J	NA	NA	**3.69**
Lead	14	0.54	NA	NA	NA	**0.666**	NA	NA	**1.23**
Mercury	2.1	0.012	0.14	NA	NA	0.2 U	NA	NA	0.2 U
Nickel	440	49	610	NA	NA	7.47	NA	NA	2.93
Selenium	20	5	NA	NA	NA	0.4 B	NA	NA	0.2 B
Silver	0.32	NA	NA	NA	NA	0.015 B	NA	NA	0.03
Zinc	35	32	NA	NA	NA	3.9	NA	NA	3.2
Semivolatile Organics (ug/L)									
Naphthalene	NA	NA	NA	0.40 UJ	NA	NA	0.13 J	NA	NA
2-Methylnaphthalene	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
1-Methylnaphthalene	NL	NL	NL	0.14 J	NA	NA	0.32 U	NA	NA
Biphenyl	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
2,6-Dimethylnaphthalene	NL	NL	NL	0.40 UJ	NA	NA	0.065 J	NA	NA
Acenaphthylene	NA	NA	NA	0.40 UJ	NA	NA	0.40 U	NA	NA
Acenaphthene	NA	NA	NA	0.33 J	NA	NA	0.62	NA	NA
2,3,5-Trimethylnaphthalene	NL	NL	NL	0.40 UJ	NA	NA	0.072 J	NA	NA
Fluorene	NA	NA	1300	0.40 UJ	NA	NA	0.20 J	NA	NA
Phenanthrene	NA	NA	NA	0.40 UJ	NA	NA	0.28 J	NA	NA
Anthracene	NA	NA	9600	0.40 UJ	NA	NA	0.024 J	NA	NA
1-Methylphenanthrene	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
Fluoranthene	NA	NA	300	0.40 UJ	NA	NA	0.057 J	NA	NA
Pyrene	NA	NA	960	0.40 UJ	NA	NA	0.069 J	NA	NA
Benz(a)anthracene	NA	NA	0.0028	0.40 UJ	NA	NA	0.40 U	NA	NA
Chrysene	NA	NA	0.0028	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(b)fluoranthene	NA	NA	0.0028	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(k)fluoranthene	NA	NA	0.0028	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(e)pyrene	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(a)pyrene	NA	NA	0.0028	0.40 UJ	NA	NA	0.40 U	NA	NA
Perylene	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.0028	0.40 UJ	NA	NA	0.40 U	NA	NA
Dibenz(a,h)anthracene	NA	NA	0.0028	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	0.40 UJ	NA	NA	0.40 U	NA	NA
Dimethyl phthalate	NA	NA	313000	10 UJ	NA	NA	9.9 U	NA	NA
Diethyl phthalate	NA	NA	23000	0.51 J	NA	NA	9.9 U	NA	NA
Di-n-butyl phthalate	NA	NA	2700	10 UJ	NA	NA	9.9 U	NA	NA

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Do Not Quote or Cite.
This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or in part.

Sample ID: Lab ID: Date Sampled:	Maximum Criteria	Continuous Criteria	Consumption of Water and Organisms Criteria	T4-CM2-1 K2402978-006 04/07/2004	T4-CM2-2 K2402978-007 04/20/2004	T4 CM2-3 K2403293-001 05/02/2004	T4CM2-4 K2403459-001 05/08/2004	T4-CM2-5 K2403657-001 05/14/2004	T4 CM2-6 K2403768-001 05/19/2004
Butylbenzyl phthalate	NA	NA	NA	10 UJ	NA	NA	9.9 U	NA	NA
Bis(2-ethylhexyl) phthalate	NA	NA	1.8	10 UJ	NA	NA	9.9 U	NA	NA
Di-n-octyl phthalate	NA	NA	NA	10 UJ	NA	NA	9.9 U	NA	NA
Total PAHs (a,b)	NL	NL	NL	0.33 J	NA	NA	1.4	NA	NA
Pesticides (ug/L)									
4,4'-DDE	NA	NA	0.00059	NA	0.10 U	NA	NA	0.10 U	NA
4,4'-DDD	NA	NA	0.00083	NA	0.10 U	NA	NA	0.10 U	NA
4,4'-DDT	1.1	0.001	0.00059	NA	0.10 U	NA	NA	0.10 U	NA
2,4'-DDE	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
2,4'-DDD	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
2,4'-DDT	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Total DDD (a,c)	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Total DDE (a,d)	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Total DDT (a,e)	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
ΣDDTs (a,f)	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
PCBs (ug/L)									
Aroclor 1016	NA	0.014	NA	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1221	NA	0.014	NA	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1232	NA	0.014	NA	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1242	NA	0.014	NA	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1248	NA	0.014	NA	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1254	NA	0.014	NA	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1260	NA	0.014	NA	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1262	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1268	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Total PCBs (a,g)	NA	NA	0.00017	NA	0.10 U	NA	NA	0.10 U	NA

Table K-1
TCLT Leachate Chemistry Results Compared to Federal Surface Water Quality Criteria

Sample ID: Lab ID: Date Sampled:	Maximum Criteria	Continuous Criteria	Consumption of Water and Organisms Criteria	T4-CM2-7 K2403995-001 05/25/2004	T4-CM2-8 K2404064-001 06/01/2004	T4-CM2-9 K2404308-001 06/08/2004	T4-CM2-10 K2404410-001 06/14/2004	T4-CM2-11 K2404715-001 06/24/2004	T4-CM2-12 K2404838-001 06/30/2004
Metals (ug/L)									
Arsenic	360	190	0.018	NA	NA	3.8	NA	NA	4.1
Cadmium	0.82	0.37	NA	NA	NA	0.11	NA	NA	0.11
Chromium	180	57	NA	NA	NA	3.97	NA	NA	4.17
Copper	4.6	3.5	NA	NA	NA	**6.55**	NA	NA	**13.3**
Lead	14	0.54	NA	NA	NA	**2.5**	NA	NA	**5.77**
Mercury	2.1	0.012	0.14	NA	NA	0.2 U	NA	NA	0.2 U
Nickel	440	49	610	NA	NA	2.95	NA	NA	2.4
Selenium	20	5	NA	NA	NA	1 UJ	NA	NA	1 U
Silver	0.32	NA	NA	NA	NA	0.057 U	NA	NA	0.09
Zinc	35	32	NA	NA	NA	4.51	NA	NA	10.2
Semivolatile Organics (ug/L)									
Naphthalene	NA	NA	NA	0.14 J	NA	NA	0.15 J	NA	NA
2-Methylnaphthalene	NL	NL	NL	0.39 UJ	NA	NA	0.066 J	NA	NA
1-Methylnaphthalene	NL	NL	NL	0.25 J	NA	NA	0.43	NA	NA
Biphenyl	NL	NL	NL	0.39 UJ	NA	NA	0.41 U	NA	NA
2,6-Dimethylnaphthalene	NL	NL	NL	0.051 J	NA	NA	0.096 J	NA	NA
Acenaphthylene	NA	NA	NA	0.39 UJ	NA	NA	0.41 U	NA	NA
Acenaphthene	NA	NA	NA	0.46 J	NA	NA	0.78	NA	NA
2,3,5-Trimethylnaphthalene	NL	NL	NL	0.39 UJ	NA	NA	0.077 J	NA	NA
Fluorene	NA	NA	1300	0.15 J	NA	NA	0.24 J	NA	NA
Phenanthrene	NA	NA	NA	0.22 J	NA	NA	0.29 J	NA	NA
Anthracene	NA	NA	9600	0.39 UJ	NA	NA	0.033 J	NA	NA
1-Methylphenanthrene	NL	NL	NL	0.39 UJ	NA	NA	0.41 U	NA	NA
Fluoranthene	NA	NA	300	0.060 J	NA	NA	0.41 UJ	NA	NA
Pyrene	NA	NA	960	0.064 J	NA	NA	0.096 J	NA	NA
Benz(a)anthracene	NA	NA	0.0028	0.39 UJ	NA	NA	0.41 U	NA	NA
Chrysene	NA	NA	0.0028	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(b)fluoranthene	NA	NA	0.0028	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(k)fluoranthene	NA	NA	0.0028	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(e)pyrene	NL	NL	NL	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(a)pyrene	NA	NA	0.0028	0.39 UJ	NA	NA	0.41 U	NA	NA
Perylene	NL	NL	NL	0.39 UJ	NA	NA	0.41 U	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.0028	0.39 UJ	NA	NA	0.41 U	NA	NA
Dibenz(a,h)anthracene	NA	NA	0.0028	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	0.39 UJ	NA	NA	0.41 U	NA	NA
Dimethyl phthalate	NA	NA	313000	9.6 UJ	NA	NA	11 U	NA	NA
Diethyl phthalate	NA	NA	23000	9.6 UJ	NA	NA	11 U	NA	NA
Di-n-butyl phthalate	NA	NA	2700	9.6 UJ	NA	NA	11 U	NA	NA

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Sample ID: Lab ID: Date Sampled:	Maximum Criteria	Continuous Criteria	Consumption of Water and Organisms Criteria	T4-CM2-7 K2403995-001 05/25/2004	T4-CM2-8 K2404064-001 06/01/2004	T4-CM2-9 K2404308-001 06/08/2004	T4-CM2-10 K2404410-001 06/14/2004	T4-CM2-11 K2404715-001 06/24/2004	T4-CM2-12 K2404838-001 06/30/2004
Butylbenzyl phthalate	NA	NA	NA	9.6 UJ	NA	NA	11 U	NA	NA
Bis(2-ethylhexyl) phthalate	NA	NA	1.8	9.6 UJ	NA	NA	11 U	NA	NA
Di-n-octyl phthalate	NA	NA	NA	9.6 UJ	NA	NA	11 U	NA	NA
Total PAHs (a,b)	NL	NL	NL	1.1 J	NA	NA	1.6	NA	NA
Pesticides (ug/L)									
4,4'-DDE	NA	NA	0.00059	NA	0.0054 J	NA	NA	0.12 U	NA
4,4'-DDD	NA	NA	0.00083	NA	0.10 U	NA	NA	0.12 U	NA
4,4'-DDT	1.1	0.001	0.00059	NA	0.10 U	NA	NA	0.12 U	NA
2,4'-DDE	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
2,4'-DDD	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
2,4'-DDT	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Total DDD (a,c)	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Total DDE (a,d)	NL	NL	NL	NA	0.0054 J	NA	NA	0.12 U	NA
Total DDT (a,e)	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
ΣDDTs (a,f)	NL	NL	NL	NA	0.0054 J	NA	NA	0.12 U	NA
PCBs (ug/L)									
Aroclor 1016	NA	0.014	NA	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1221	NA	0.014	NA	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1232	NA	0.014	NA	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1242	NA	0.014	NA	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1248	NA	0.014	NA	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1254	NA	0.014	NA	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1260	NA	0.014	NA	NA	0.10 UJ	NA	NA	0.12 U	NA
Aroclor 1262	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1268	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Total PCBs (a,g)	NA	NA	0.00017	NA	0.10 U	NA	NA	0.12 U	NA

TCLT Leachate Chemistry Results Compared to Federal Surface Water Quality Criteria

	Maximum Criteria	Continuous Criteria	Consumption of Water and Organisms Criteria	T4-CM2-13 K2405086-001 07/08/2004	T4-CM2-14 K2405177-001 07/13/2004	T4-CM2-15 K2405298-001 07/19/2004	T4-CM2-16 K2405510-001 07/23/2004	T4-CM2-17 K2405532-001 07/27/2004	T4-CM2-18 K2405675-001 07/27/2004
Sample ID: / **Lab ID:** / **Date Sampled:**									
Metals (ug/L)									
Arsenic	360	190	0.018	NA	NA	2.3	NA	NA	2.4
Cadmium	0.82	0.37	NA	NA	NA	0.06	NA	NA	0.1
Chromium	180	57	NA	NA	NA	1.85	NA	NA	2.1
Copper	4.6	3.5	NA	NA	NA	**5.61**	NA	NA	**6.57**
Lead	14	0.54	NA	NA	NA	**2.37**	NA	NA	**3.02**
Mercury	2.1	0.012	0.14	NA	NA	0.2 UJ	NA	NA	0.2 U
Nickel	440	49	610	NA	NA	0.9 J	NA	NA	1.25
Selenium	20	5	NA	NA	NA	1 U	NA	NA	1 U
Silver	0.32	NA	NA	NA	NA	0.07 U	NA	NA	0.08 U
Zinc	35	32	NA	NA	NA	4	NA	NA	6.2
Semivolatile Organics (ug/L)									
Naphthalene	NA	NA	NA	0.43 U	NA	NA	0.49 U	NA	NA
2-Methylnaphthalene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
1-Methylnaphthalene	NL	NL	NL	0.43 U	NA	NA	0.12 J	NA	NA
Biphenyl	NL	NL	NL	0.11 J	NA	NA	0.49 U	NA	NA
2,6-Dimethylnaphthalene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Acenaphthylene	NA	NA	NA	0.43 U	NA	NA	0.049 J	NA	NA
Acenaphthene	NA	NA	NA	0.43 U	NA	NA	0.39 J	NA	NA
2,3,5-Trimethylnaphthalene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Fluorene	NA	NA	1300	0.43 U	NA	NA	0.098 J	NA	NA
Phenanthrene	NA	NA	NA	0.43 U	NA	NA	0.49 U	NA	NA
Anthracene	NA	NA	9600	0.43 U	NA	NA	0.49 U	NA	NA
1-Methylphenanthrene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Fluoranthene	NA	NA	300	0.43 U	NA	NA	0.20 J	NA	NA
Pyrene	NA	NA	960	0.43 U	NA	NA	0.096 J	NA	NA
Benz(a)anthracene	NA	NA	0.0028	0.43 U	NA	NA	0.49 U	NA	NA
Chrysene	NA	NA	0.0028	0.43 U	NA	NA	0.034 J	NA	NA
Benzo(b)fluoranthene	NA	NA	0.0028	0.43 U	NA	NA	0.49 U	NA	NA
Benzo(k)fluoranthene	NA	NA	0.0028	0.43 U	NA	NA	0.49 U	NA	NA
Benzo(e)pyrene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Benzo(a)pyrene	NA	NA	0.0028	0.43 U	NA	NA	0.49 U	NA	NA
Perylene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.0028	0.43 U	NA	NA	0.49 U	NA	NA
Dibenz(a,h)anthracene	NA	NA	0.0028	0.43 U	NA	NA	0.49 UJ	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	0.43 U	NA	NA	0.49 U	NA	NA
Dimethyl phthalate	NA	NA	313000	11 U	NA	NA	13 U	NA	NA
Diethyl phthalate	NA	NA	23000	11 U	NA	NA	13 U	NA	NA
Di-n-butyl phthalate	NA	NA	2700	11 U	NA	NA	13 U	NA	NA

Sample ID: Lab ID: Date Sampled:	Maximum Criteria	Continuous Criteria	Consumption of Water and Organisms Criteria	T4-CM2-13 K2405086-001 07/08/2004	T4-CM2-14 K2405177-001 07/13/2004	T4-CM2-15 K2405298-001 07/19/2004	T4-CM2-16 K2405510-001 07/23/2004	T4-CM2-17 K2405532-001 07/27/2004	T4-CM2-18 K2405675-001 07/27/2004
Butylbenzyl phthalate	NA	NA	NA	11 U	NA	NA	13 U	NA	NA
Bis(2-ethylhexyl) phthalate	NA	NA	1.8	11 U	NA	NA	13 U	NA	NA
Di-n-octyl phthalate	NA	NA	NA	11 U	NA	NA	13 U	NA	NA
Total PAHs (a,b)	NL	NL	NL	0.43 U	NA	NA	0.87 J	NA	NA
Pesticides (ug/L)									
4,4'-DDE	NA	NA	0.00059	NA	0.11 U	NA	NA	0.10 U	NA
4,4'-DDD	NA	NA	0.00083	NA	0.11 U	NA	NA	0.10 U	NA
4,4'-DDT	1.1	0.001	0.00059	NA	0.11 U	NA	NA	0.10 U	NA
2,4'-DDE	NL	NL	NL	NA	0.11 U	NA	NA	0.10 U	NA
2,4'-DDD	NL	NL	NL	NA	0.0013 J	NA	NA	0.00084 J	NA
2,4'-DDT	NL	NL	NL	NA	0.11 U	NA	NA	0.10 U	NA
Total DDD (a,c)	NL	NL	NL	NA	0.0013 J	NA	NA	0.00084 J	NA
Total DDE (a,d)	NL	NL	NL	NA	0.11 U	NA	NA	0.10 U	NA
Total DDT (a,e)	NL	NL	NL	NA	0.11 U	NA	NA	0.10 U	NA
ΣDDTs (a,f)	NL	NL	NL	NA	0.0013 J	NA	NA	0.00084 J	NA
PCBs (ug/L)									
Aroclor 1016	NA	0.014	NA	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1221	NA	0.014	NA	NA	0.43 U	NA	NA	0.10 U	NA
Aroclor 1232	NA	0.014	NA	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1242	NA	0.014	NA	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1248	NA	0.014	NA	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1254	NA	0.014	NA	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1260	NA	0.014	NA	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1262	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1268	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Total PCBs (a,g)	NA	NA	0.00017	NA	0.43 U	NA	NA	0.10 U	NA

Sample ID: Lab ID: Date Sampled:	Maximum Criteria	Continuous Criteria	Consumption of Water and Organisms Criteria	T4-CM2-19 K2405739-001 08/03/2004	T4-CM2-20 K2405932-001 08/06/2004	T4-CM2-21 K2405932-002 08/06/2004	T4-CM2-22 K2406120-001 08/14/2004	T4-CM2-23 K2406266-001 08/18/2004	T4-CM2-24 K2406359-001 08/22/2004
Metals (ug/L)									
Arsenic	360	190	0.018	NA	NA	2.5	NA	NA	2.59
Cadmium	0.82	0.37	NA	NA	NA	0.13	NA	NA	0.1
Chromium	180	57	NA	NA	NA	2.22	NA	NA	2.39
Copper	4.6	3.5	NA	NA	NA	**7.43**	NA	NA	**6.78**
Lead	14	0.54	NA	NA	NA	**3.16**	NA	NA	**2.9**
Mercury	2.1	0.012	0.14	NA	NA	0.2 UJ	NA	NA	0.2 U
Nickel	440	49	610	NA	NA	1.36 U	NA	NA	1.52
Selenium	20	5	NA	NA	NA	1 U	NA	NA	1 U
Silver	0.32	NA	NA	NA	NA	0.08 U	NA	NA	0.051
Zinc	35	32	NA	NA	NA	6.3	NA	NA	6.36
Semivolatile Organics (ug/L)									
Naphthalene	NA	NA	NA	0.12 J	NA	NA	0.40 U	NA	NA
2-Methylnaphthalene	NL	NL	NL	0.068 J	NA	NA	0.40 U	NA	NA
1-Methylnaphthalene	NL	NL	NL	0.23 J	NA	NA	0.40 U	NA	NA
Biphenyl	NL	NL	NL	0.40 U	NA	NA	0.40 U	NA	NA
2,6-Dimethylnaphthalene	NL	NL	NL	0.074 J	NA	NA	0.40 U	NA	NA
Acenaphthylene	NA	NA	NA	0.40 U	NA	NA	0.40 U	NA	NA
Acenaphthene	NA	NA	NA	0.50	NA	NA	0.21 J	NA	NA
2,3,5-Trimethylnaphthalene	NL	NL	NL	0.064 J	NA	NA	0.40 U	NA	NA
Fluorene	NA	NA	1300	0.19 J	NA	NA	0.40 U	NA	NA
Phenanthrene	NA	NA	NA	0.36 J	NA	NA	0.40 U	NA	NA
Anthracene	NA	NA	9600	0.40 U	NA	NA	0.40 U	NA	NA
1-Methylphenanthrene	NL	NL	NL	0.40 U	NA	NA	0.40 U	NA	NA
Fluoranthene	NA	NA	300	0.40 U	NA	NA	0.40 U	NA	NA
Pyrene	NA	NA	960	0.40 U	NA	NA	0.40 U	NA	NA
Benz(a)anthracene	NA	NA	0.0028	0.40 U	NA	NA	0.40 U	NA	NA
Chrysene	NA	NA	0.0028	0.40 U	NA	NA	0.40 U	NA	NA
Benzo(b)fluoranthene	NA	NA	0.0028	0.40 U	NA	NA	0.40 U	NA	NA
Benzo(k)fluoranthene	NA	NA	0.0028	0.40 U	NA	NA	0.40 U	NA	NA
Benzo(e)pyrene	NL	NL	NL	0.40 U	NA	NA	0.40 U	NA	NA
Benzo(a)pyrene	NA	NA	0.0028	0.40 U	NA	NA	0.40 U	NA	NA
Perylene	NL	NL	NL	0.40 U	NA	NA	0.40 U	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.0028	0.40 U	NA	NA	0.40 U	NA	NA
Dibenz(a,h)anthracene	NA	NA	0.0028	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	0.40 U	NA	NA	0.40 U	NA	NA
Dimethyl phthalate	NA	NA	313000	10 U	NA	NA	10 U	NA	NA
Diethyl phthalate	NA	NA	23000	10 U	NA	NA	10 U	NA	NA
Di-n-butyl phthalate	NA	NA	2700	10 U	NA	NA	10 U	NA	NA

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Table K-1
TCLT Leachate Chemistry Results Compared to Federal Surface Water Quality Criteria

Sample ID: Lab ID: Date Sampled:	Maximum Criteria	Continuous Criteria	Consumption of Water and Organisms Criteria	T4-CM2-19 K2405739-001 08/03/2004	T4-CM2-20 K2405932-001 08/06/2004	T4-CM2-21 K2405932-002 08/06/2004	T4-CM2-22 K2406120-001 08/14/2004	T4-CM2-23 K2406266-001 08/18/2004	T4-CM2-24 K2406359-001 08/22/2004
Butylbenzyl phthalate	NA	NA	NA	10 U	NA	NA	10 U	NA	NA
Bis(2-ethylhexyl) phthalate	NA	NA	1.8	10 U	NA	NA	10 U	NA	NA
Di-n-octyl phthalate	NA	NA	NA	3.9 J	NA	NA	10 U	NA	NA
Total PAHs (a,b)	NL	NL	NL	1.2	NA	NA	0.21 J	NA	NA
Pesticides (ug/L)									
4,4'-DDE	NA	NA	0.00059	NA	0.098 U	NA	NA	0.11 U	NA
4,4'-DDD	NA	NA	0.00083	NA	0.098 U	NA	NA	0.11 U	NA
4,4'-DDT	1.1	0.001	0.00059	NA	0.098 U	NA	NA	0.11 U	NA
2,4'-DDE	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
2,4'-DDD	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
2,4'-DDT	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
Total DDD (a,c)	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
Total DDE (a,d)	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
Total DDT (a,e)	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
ΣDDTs (a,f)	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
PCBs (ug/L)									
Aroclor 1016	NA	0.014	NA	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1221	NA	0.014	NA	NA	0.39 U	NA	NA	0.11 U	NA
Aroclor 1232	NA	0.014	NA	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1242	NA	0.014	NA	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1248	NA	0.014	NA	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1254	NA	0.014	NA	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1260	NA	0.014	NA	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1262	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1268	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Total PCBs (a,g)	NA	NA	0.00017	NA	0.39 U	NA	NA	0.11 U	NA

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U = Analyte was not detected above the reported sample quantitation limit.

J = Analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ = Analyte was not detected above the reported sample quantitation limit. The reported quantitation limit is approximate.

B = Analyte was positvely identified; the associated numerical value is the approximate concentration of the analyte in the sample.
   The approximate concentration is less than the method report limit but greater than the method detection limit.

NA = No criterion available or compound not analyzed.

NL = Compound not listed.

Box exceeds maximum criteria.

Bold box exceeds continuous criteria.

Shaded exceeds consumption of water and organisms criteria.

a. Total concentrations are calculated using the detected concentrations of individual constituents. Non-detects are treated as zeros. If all the individual constituents are
   non-detect, the total concentration is reported as non-detect using the highest detection limit.

b. Swartz, 1999, which MacDonald et al., 2000a references as the source of the PAH screening levels, describes
   the total PAH criteria as the sum of the following polycyclic aromatic compounds: naphthalene, acenaphthylene, acenaphthene, fluorene,
   phenanthrene, anthracene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene.

c. The total DDD criteria represent the sum of the following compounds: 2,4'-DDD and 4,4'-DDD.

d. The total DDE criteria represent the sum of the following compounds: 2,4'-DDE and 4,4'-DDE.

e. The total DDT criteria represent the sum of the following compounds: 2,4'-DDT and 4,4'-DDT.

f. ΣDDTs criteria represent the sum of the following compounds: total DDD, total DDE, and total DDT. See footnotes c, d, and e for the definitions
   of total DDD, total DDE, and total DDT, respectively.

g. MacDonald et al., 2000b, which MacDonald et al., 2000a references as the source of the PCB screening levels, does not describe which individual Aroclors make
   up the total PCB criteria. It was assumed that total PCBs consisted of all the Aroclors that were analyzed for (Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor
   1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, Aroclor 1262, and Aroclor 1268).

Table K-2
TCLT Leachate Chemistry Results Compared to Oregon State Surface Water Quality Criteria

	Acute Critera	Chronic Criteria	Water and Fish Ingestion Criteria	T4-CM2-1 K2402978-006 04/07/2004	T4-CM2-2 K2402978-007 04/20/2004	T4 CM2-3 K2403293-001 05/02/2004	T4CM2-4 K2403459-001 05/08/2004	T4-CM2-5 K2403657-001 05/14/2004	T4 CM2-6 K2403768-001 05/19/2004
Sample ID: Lab ID: Date Sampled:									
Metals (ug/L)									
Arsenic	340	150	0.018	NA	NA	3.2	NA	NA	2.4
Cadmium	0.52	0.094	10	NA	NA	**0.21**	NA	NA	**0.07**
Chromium	180	24	170,000	NA	NA	4.3	NA	NA	3.21
Copper	3.6	2.7	1,300	NA	NA	**3.81** J	NA	NA	**3.69**
Lead	14	0.54	50	NA	NA	**0.666**	NA	NA	**1.23**
Mercury	2.4	0.012	0.144	NA	NA	0.2 U	NA	NA	0.2 U
Nickel	150	16	610	NA	NA	7.47	NA	NA	2.93
Selenium	260	5	170	NA	NA	0.4 B	NA	NA	0.2 B
Silver	0.30	0.1	50	NA	NA	0.015 B	NA	NA	0.03
Zinc	36	36	7400	NA	NA	3.9	NA	NA	3.2
Semivolatile Organics (ug/L)									
Naphthalene	2300	620	NA	0.40 UJ	NA	NA	0.13 J	NA	NA
2-Methylnaphthalene	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
1-Methylnaphthalene	NL	NL	NL	0.14 J	NA	NA	0.32 J	NA	NA
Biphenyl	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
2,6-Dimethylnaphthalene	NL	NL	NL	0.40 UJ	NA	NA	0.065 J	NA	NA
Acenaphthylene	NA	NA	NA	0.40 UJ	NA	NA	0.40 U	NA	NA
Acenaphthene	1,700	520	670	0.33 J	NA	NA	0.62	NA	NA
2,3,5-Trimethylnaphthalene	NL	NL	NL	0.40 UJ	NA	NA	0.072 J	NA	NA
Fluorene	NA	NA	1,100	0.40 UJ	NA	NA	0.20 J	NA	NA
Phenanthrene	NA	NA	NA	0.40 UJ	NA	NA	0.28 J	NA	NA
Anthracene	NA	NA	8,300	0.40 UJ	NA	NA	0.024 J	NA	NA
1-Methylphenanthrene	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
Fluoranthene	3,980	NA	130	0.40 UJ	NA	NA	0.057 J	NA	NA
Pyrene	NA	NA	830	0.40 UJ	NA	NA	0.069 J	NA	NA
Benz(a)anthracene	NA	NA	0.0038	0.40 UJ	NA	NA	0.40 U	NA	NA
Chrysene	NA	NA	0.0038	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(b)fluoranthene	NA	NA	0.0038	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(k)fluoranthene	NA	NA	0.0038	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(e)pyrene	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(a)pyrene	NA	NA	0.0038	0.40 UJ	NA	NA	0.40 U	NA	NA
Perylene	NL	NL	NL	0.40 UJ	NA	NA	0.40 U	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.0038	0.40 UJ	NA	NA	0.40 U	NA	NA
Dibenz(a,h)anthracene	NA	NA	0.0038	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	0.40 UJ	NA	NA	0.40 U	NA	NA
Dimethyl phthalate	NA	NA	270,000	10 UJ	NA	NA	9.9 U	NA	NA
Diethyl phthalate	NA	NA	17,000	0.51 J	NA	NA	9.9 U	NA	NA
Di-n-butyl phthalate	NA	NA	2,000	10 UJ	NA	NA	9.9 U	NA	NA

Sample ID: Lab ID: Date Sampled:	Acute Critera	Chronic Criteria	Water and Fish Ingestion Criteria	T4-CM2-1 K2402978-006 04/07/2004	T4-CM2-2 K2402978-007 04/20/2004	T4 CM2-3 K2403293-001 05/02/2004	T4CM2-4 K2403459-001 05/08/2004	T4-CM2-5 K2403657-001 05/14/2004	T4 CM2-6 K2403768-001 05/19/2004
Butylbenzyl phthalate	NA	NA	1,500	10 UJ	NA	NA	9.9 U	NA	NA
Bis(2-ethylhexyl) phthalate	NA	NA	1.2	10 UJ	NA	NA	9.9 U	NA	NA
Di-n-octyl phthalate	NA	NA	NA	10 UJ	NA	NA	9.9 U	NA	NA
Total PAHs (a,b)	NA	NA	0.0028	0.33 J	NA	NA	1.4	NA	NA
Pesticides (ug/L)									
4,4'-DDE	1,050	NA	0.00022	NA	0.10 U	NA	NA	0.10 U	NA
4,4'-DDD	0.06	NA	0.00031	NA	0.10 U	NA	NA	0.10 U	NA
4,4'-DDT	1.1	0.001	0.00022	NA	0.10 U	NA	NA	0.10 U	NA
2,4'-DDE	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
2,4'-DDD	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
2,4'-DDT	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Total DDD (a,c)	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Total DDE (a,d)	NA	NA	NA	NA	0.10 U	NA	NA	0.10 U	NA
Total DDT (a,e)	1.1	0.001	0.000024	NA	0.10 U	NA	NA	0.10 U	NA
ΣDDTs (a,f)	1.1	0.001	NA	NA	0.10 U	NA	NA	0.10 U	NA
PCBs (ug/L)									
Aroclor 1016	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1221	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1232	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1242	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1248	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1254	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1260	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1262	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Aroclor 1268	NL	NL	NL	NA	0.10 U	NA	NA	0.10 U	NA
Total PCBs (a,g)	2	0.014	0.000064	NA	0.10 U	NA	NA	0.10 U	NA

Table K-2
TCLT Leachate Chemistry Results Compared to Oregon State Surface Water Quality Criteria

Sample ID: Lab ID: Date Sampled:	Acute Critera	Chronic Criteria	Water and Fish Ingestion Criteria	T4-CM2-7 K2403995-001 05/25/2004	T4-CM2-8 K2404064-001 06/01/2004	T4-CM2-9 K2404308-001 06/08/2004	T4-CM2-10 K2404410-001 06/14/2004	T4-CM2-11 K2404715-001 06/24/2004	T4-CM2-12 K2404838-001 06/30/2004
Metals (ug/L)									
Arsenic	340	150	0.018	NA	NA	3.8	NA	NA	4.1
Cadmium	0.52	0.094	10	NA	NA	**0.11**	NA	NA	**0.11**
Chromium	180	24	170,000	NA	NA	3.97	NA	NA	4.17
Copper	3.6	2.7	1,300	NA	NA	6.55	NA	NA	13.3
Lead	14	0.54	50	NA	NA	**2.5**	NA	NA	**5.77**
Mercury	2.4	0.012	0.144	NA	NA	0.2 U	NA	NA	0.2 U
Nickel	150	16	610	NA	NA	2.95	NA	NA	2.4
Selenium	260	5	170	NA	NA	1 UJ	NA	NA	1 U
Silver	0.30	0.1	50	NA	NA	0.057 U	NA	NA	0.09
Zinc	36	36	7400	NA	NA	4.51	NA	NA	10.2
Semivolatile Organics (ug/L)									
Naphthalene	2300	620	NA	0.14 J	NA	NA	0.15 J	NA	NA
2-Methylnaphthalene	NL	NL	NL	0.39 J	NA	NA	0.066 J	NA	NA
1-Methylnaphthalene	NL	NL	NL	0.25 J	NA	NA	0.43	NA	NA
Biphenyl	NL	NL	NL	0.39 UJ	NA	NA	0.41 U	NA	NA
2,6-Dimethylnaphthalene	NL	NL	NL	0.051 J	NA	NA	0.096 J	NA	NA
Acenaphthylene	NA	NA	NA	0.39 UJ	NA	NA	0.41 U	NA	NA
Acenaphthene	1,700	520	670	0.46 J	NA	NA	0.78	NA	NA
2,3,5-Trimethylnaphthalene	NL	NL	NL	0.39 UJ	NA	NA	0.077 J	NA	NA
Fluorene	NA	NA	1,100	0.15 J	NA	NA	0.24 J	NA	NA
Phenanthrene	NA	NA	NA	0.22 J	NA	NA	0.29 J	NA	NA
Anthracene	NA	NA	8,300	0.39 UJ	NA	NA	0.033 J	NA	NA
1-Methylphenanthrene	NL	NL	NL	0.39 UJ	NA	NA	0.41 U	NA	NA
Fluoranthene	3,980	NA	130	0.060 J	NA	NA	0.41 UJ	NA	NA
Pyrene	NA	NA	830	0.064 J	NA	NA	0.096 J	NA	NA
Benz(a)anthracene	NA	NA	0.0038	0.39 UJ	NA	NA	0.41 U	NA	NA
Chrysene	NA	NA	0.0038	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(b)fluoranthene	NA	NA	0.0038	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(k)fluoranthene	NA	NA	0.0038	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(e)pyrene	NL	NL	NL	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(a)pyrene	NA	NA	0.0038	0.39 UJ	NA	NA	0.41 U	NA	NA
Perylene	NL	NL	NL	0.39 UJ	NA	NA	0.41 U	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.0038	0.39 UJ	NA	NA	0.41 U	NA	NA
Dibenz(a,h)anthracene	NA	NA	0.0038	0.39 UJ	NA	NA	0.41 U	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	0.39 UJ	NA	NA	0.41 U	NA	NA
Dimethyl phthalate	NA	NA	270,000	9.6 UJ	NA	NA	11 U	NA	NA
Diethyl phthalate	NA	NA	17,000	9.6 UJ	NA	NA	11 U	NA	NA
Di-n-butyl phthalate	NA	NA	2,000	9.6 UJ	NA	NA	11 U	NA	NA

Sample ID: Lab ID: Date Sampled:	Acute Critera	Chronic Criteria	Water and Fish Ingestion Criteria	T4-CM2-7 K2403995-001 05/25/2004	T4-CM2-8 K2404064-001 06/01/2004	T4-CM2-9 K2404308-001 06/08/2004	T4-CM2-10 K2404410-001 06/14/2004	T4-CM2-11 K2404715-001 06/24/2004	T4-CM2-12 K2404838-001 06/30/2004
Butylbenzyl phthalate	NA	NA	1,500	9.6 UJ	NA	NA	11 U	NA	NA
Bis(2-ethylhexyl) phthalate	NA	NA	1.2	9.6 UJ	NA	NA	11 U	NA	NA
Di-n-octyl phthalate	NA	NA	NA	9.6 UJ	NA	NA	11 U	NA	NA
Total PAHs (a,b)	NA	NA	0.0028	1.1 J	NA	NA	1.6	NA	NA
Pesticides (ug/L)									
4,4'-DDE	1,050	NA	0.00022	NA	0.0054 J	NA	NA	0.12 U	NA
4,4'-DDD	0.06	NA	0.00031	NA	0.10 U	NA	NA	0.12 U	NA
4,4'-DDT	1.1	0.001	0.00022	NA	0.10 U	NA	NA	0.12 U	NA
2,4'-DDE	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
2,4'-DDD	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
2,4'-DDT	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Total DDD (a,c)	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Total DDE (a,d)	NA	NA	NA	NA	0.0054 J	NA	NA	0.12 U	NA
Total DDT (a,e)	1.1	0.001	0.000024	NA	0.10 U	NA	NA	0.12 U	NA
ΣDDTs (a,f)	1.1	0.001	NA	NA	**0.0054** J	NA	NA	0.12 U	NA
PCBs (ug/L)									
Aroclor 1016	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1221	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1232	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1242	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1248	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1254	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1260	NL	NL	NL	NA	0.10 UJ	NA	NA	0.12 U	NA
Aroclor 1262	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Aroclor 1268	NL	NL	NL	NA	0.10 U	NA	NA	0.12 U	NA
Total PCBs (a,g)	2	0.014	0.000064	NA	0.10 U	NA	NA	0.12 U	NA

Table K-2
TCLT Leachate Chemistry Results Compared to Oregon State Surface Water Quality Criteria

	Acute Critera	Chronic Criteria	Water and Fish Ingestion Criteria	T4-CM2-13 K2405086-001 07/08/2004	T4-CM2-14 K2405177-001 07/13/2004	T4-CM2-15 K2405298-001 07/19/2004	T4-CM2-16 K2405510-001 07/23/2004	T4-CM2-17 K2405532-001 07/27/2004	T4-CM2-18 K2405675-001 07/27/2004
Sample ID:									
Lab ID:									
Date Sampled:									
Metals (ug/L)									
Arsenic	340	150	0.018	NA	NA	2.3	NA	NA	2.4
Cadmium	0.52	0.094	10	NA	NA	0.06	NA	NA	**0.1**
Chromium	180	24	170,000	NA	NA	1.85	NA	NA	2.1
Copper	3.6	2.7	1,300	NA	NA	**5.61**	NA	NA	**6.57**
Lead	14	0.54	50	NA	NA	**2.37**	NA	NA	**3.02**
Mercury	2.4	0.012	0.144	NA	NA	0.2 UJ	NA	NA	0.2 U
Nickel	150	16	610	NA	NA	0.9 J	NA	NA	1.25
Selenium	260	5	170	NA	NA	1 U	NA	NA	1 U
Silver	0.30	0.1	50	NA	NA	0.07 U	NA	NA	0.08 U
Zinc	36	36	7400	NA	NA	4	NA	NA	6.2
Semivolatile Organics (ug/L)									
Naphthalene	2300	620	NA	0.43 U	NA	NA	0.49 U	NA	NA
2-Methylnaphthalene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
1-Methylnaphthalene	NL	NL	NL	0.43 U	NA	NA	0.12 J	NA	NA
Biphenyl	NL	NL	NL	0.11 J	NA	NA	0.49 U	NA	NA
2,6-Dimethylnaphthalene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Acenaphthylene	NA	NA	NA	0.43 U	NA	NA	0.049 J	NA	NA
Acenaphthene	1,700	520	670	0.43 U	NA	NA	0.39 J	NA	NA
2,3,5-Trimethylnaphthalene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Fluorene	NA	NA	1,100	0.43 U	NA	NA	0.098 J	NA	NA
Phenanthrene	NA	NA	NA	0.43 U	NA	NA	0.49 U	NA	NA
Anthracene	NA	NA	8,300	0.43 U	NA	NA	0.49 U	NA	NA
1-Methylphenanthrene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Fluoranthene	3,980	NA	130	0.43 U	NA	NA	0.20 J	NA	NA
Pyrene	NA	NA	830	0.43 U	NA	NA	0.096 J	NA	NA
Benz(a)anthracene	NA	NA	0.0038	0.43 U	NA	NA	0.49 U	NA	NA
Chrysene	NA	NA	0.0038	0.43 U	NA	NA	0.034 J	NA	NA
Benzo(b)fluoranthene	NA	NA	0.0038	0.43 U	NA	NA	0.49 U	NA	NA
Benzo(k)fluoranthene	NA	NA	0.0038	0.43 U	NA	NA	0.49 U	NA	NA
Benzo(e)pyrene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Benzo(a)pyrene	NA	NA	0.0038	0.43 U	NA	NA	0.49 U	NA	NA
Perylene	NL	NL	NL	0.43 U	NA	NA	0.49 U	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.0038	0.43 U	NA	NA	0.49 U	NA	NA
Dibenz(a,h)anthracene	NA	NA	0.0038	0.43 U	NA	NA	0.49 UJ	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	0.43 U	NA	NA	0.49 U	NA	NA
Dimethyl phthalate	NA	NA	270,000	11 U	NA	NA	13 U	NA	NA
Diethyl phthalate	NA	NA	17,000	11 U	NA	NA	13 U	NA	NA
Di-n-butyl phthalate	NA	NA	2,000	11 U	NA	NA	13 U	NA	NA

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Sample ID: Lab ID: Date Sampled:	Acute Critera	Chronic Criteria	Water and Fish Ingestion Criteria	T4-CM2-13 K2405086-001 07/08/2004	T4-CM2-14 K2405177-001 07/13/2004	T4-CM2-15 K2405298-001 07/19/2004	T4-CM2-16 K2405510-001 07/23/2004	T4-CM2-17 K2405532-001 07/27/2004	T4-CM2-18 K2405675-001 07/27/2004
Butylbenzyl phthalate	NA	NA	1,500	11 U	NA	NA	13 U	NA	NA
Bis(2-ethylhexyl) phthalate	NA	NA	1.2	11 U	NA	NA	13 U	NA	NA
Di-n-octyl phthalate	NA	NA	NA	11 U	NA	NA	13 U	NA	NA
Total PAHs (a,b)	NA	NA	0.0028	0.43 U	NA	NA	0.87 J	NA	NA
Pesticides (ug/L)									
4,4'-DDE	1,050	NA	0.00022	NA	0.11 U	NA	NA	0.10 U	NA
4,4'-DDD	0.06	NA	0.00031	NA	0.11 U	NA	NA	0.10 U	NA
4,4'-DDT	1.1	0.001	0.00022	NA	0.11 U	NA	NA	0.10 U	NA
2,4'-DDE	NL	NL	NL	NA	0.11 U	NA	NA	0.10 U	NA
2,4'-DDD	NL	NL	NL	NA	0.0013 J	NA	NA	0.00084 J	NA
2,4'-DDT	NL	NL	NL	NA	0.11 U	NA	NA	0.10 U	NA
Total DDD (a,c)	NL	NL	NL	NA	0.0013 J	NA	NA	0.00084 J	NA
Total DDE (a,d)	NA	NA	NA	NA	0.11 U	NA	NA	0.10 U	NA
Total DDT (a,e)	1.1	0.001	0.000024	NA	0.11 U	NA	NA	0.10 U	NA
ΣDDTs (a,f)	1.1	0.001	NA	NA	**0.0013 J**	NA	NA	0.00084 J	NA
PCBs (ug/L)									
Aroclor 1016	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1221	NL	NL	NL	NA	0.43 U	NA	NA	0.10 U	NA
Aroclor 1232	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1242	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1248	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1254	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1260	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1262	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Aroclor 1268	NL	NL	NL	NA	0.22 U	NA	NA	0.10 U	NA
Total PCBs (a,g)	2	0.014	0.000064	NA	0.43 U	NA	NA	0.10 U	NA

Table K-2
TCLT Leachate Chemistry Results Compared to Oregon State Surface Water Quality Criteria

Sample ID: Lab ID: Date Sampled:	Acute Critera	Chronic Criteria	Water and Fish Ingestion Criteria	T4-CM2-19 K2405739-001 08/03/2004	T4-CM2-20 K2405932-001 08/06/2004	T4-CM2-21 K2405932-002 08/06/2004	T4-CM2-22 K2406120-001 08/14/2004	T4-CM2-23 K2406266-001 08/18/2004	T4-CM2-24 K2406359-001 08/22/2004
Metals (ug/L)									
Arsenic	340	150	0.018	NA	NA	2.5	NA	NA	2.59
Cadmium	0.52	0.094	10	NA	NA	**0.13**	NA	NA	**0.1**
Chromium	180	24	170,000	NA	NA	2.22	NA	NA	2.39
Copper	3.6	2.7	1,300	NA	NA	**7.43**	NA	NA	**6.78**
Lead	14	0.54	50	NA	NA	**3.16**	NA	NA	**2.9**
Mercury	2.4	0.012	0.144	NA	NA	0.2 UJ	NA	NA	0.2 U
Nickel	150	16	610	NA	NA	1.36 U	NA	NA	1.52
Selenium	260	5	170	NA	NA	1 U	NA	NA	1 U
Silver	0.30	0.1	50	NA	NA	0.08 U	NA	NA	0.051
Zinc	36	36	7400	NA	NA	6.3	NA	NA	6.36
Semivolatile Organics (ug/L)									
Naphthalene	2300	620	NA	0.12 J	NA	NA	0.40 U	NA	NA
2-Methylnaphthalene	NL	NL	NL	0.068 J	NA	NA	0.40 U	NA	NA
1-Methylnaphthalene	NL	NL	NL	0.23 J	NA	NA	0.40 U	NA	NA
Biphenyl	NL	NL	NL	0.40 U	NA	NA	0.40 U	NA	NA
2,6-Dimethylnaphthalene	NL	NL	NL	0.074 J	NA	NA	0.40 U	NA	NA
Acenaphthylene	NA	NA	NA	0.40 U	NA	NA	0.40 U	NA	NA
Acenaphthene	1,700	520	670	0.50	NA	NA	0.21 J	NA	NA
2,3,5-Trimethylnaphthalene	NL	NL	NL	0.064 J	NA	NA	0.40 U	NA	NA
Fluorene	NA	NA	1,100	0.19 J	NA	NA	0.40 U	NA	NA
Phenanthrene	NA	NA	NA	0.36 J	NA	NA	0.40 U	NA	NA
Anthracene	NA	NA	8,300	0.40 U	NA	NA	0.40 U	NA	NA
1-Methylphenanthrene	NL	NL	NL	0.40 U	NA	NA	0.40 U	NA	NA
Fluoranthene	3,980	NA	130	0.40 U	NA	NA	0.40 U	NA	NA
Pyrene	NA	NA	830	0.40 U	NA	NA	0.40 U	NA	NA
Benz(a)anthracene	NA	NA	0.0038	0.40 U	NA	NA	0.40 U	NA	NA
Chrysene	NA	NA	0.0038	0.40 U	NA	NA	0.40 U	NA	NA
Benzo(b)fluoranthene	NA	NA	0.0038	0.40 U	NA	NA	0.40 U	NA	NA
Benzo(k)fluoranthene	NA	NA	0.0038	0.40 U	NA	NA	0.40 U	NA	NA
Benzo(e)pyrene	NL	NL	NL	0.40 U	NA	NA	0.40 U	NA	NA
Benzo(a)pyrene	NA	NA	0.0038	0.40 U	NA	NA	0.40 U	NA	NA
Perylene	NL	NL	NL	0.40 U	NA	NA	0.40 U	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.0038	0.40 U	NA	NA	0.40 U	NA	NA
Dibenz(a,h)anthracene	NA	NA	0.0038	0.40 UJ	NA	NA	0.40 U	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	0.40 U	NA	NA	0.40 U	NA	NA
Dimethyl phthalate	NA	NA	270,000	10 U	NA	NA	10 U	NA	NA
Diethyl phthalate	NA	NA	17,000	10 U	NA	NA	10 U	NA	NA
Di-n-butyl phthalate	NA	NA	2,000	10 U	NA	NA	10 U	NA	NA

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Table K-2
TCLT Leachate Chemistry Results Compared to Oregon State Surface Water Quality Criteria

Sample ID: Lab ID: Date Sampled:	Acute Critera	Chronic Criteria	Water and Fish Ingestion Criteria	T4-CM2-19 K2405739-001 08/03/2004	T4-CM2-20 K2405932-001 08/06/2004	T4-CM2-21 K2405932-002 08/06/2004	T4-CM2-22 K2406120-001 08/14/2004	T4-CM2-23 K2406266-001 08/18/2004	T4-CM2-24 K2406359-001 08/22/2004
Butylbenzyl phthalate	NA	NA	1,500	10 U	NA	NA	10 U	NA	NA
Bis(2-ethylhexyl) phthalate	NA	NA	1.2	10 U	NA	NA	10 U	NA	NA
Di-n-octyl phthalate	NA	NA	NA	3.9 J	NA	NA	10 U	NA	NA
Total PAHs (a,b)	NA	NA	0.0028	1.2	NA	NA	0.21 J	NA	NA
Pesticides (ug/L)									
4,4'-DDE	1,050	NA	0.00022	NA	0.098 U	NA	NA	0.11 U	NA
4,4'-DDD	0.06	NA	0.00031	NA	0.098 U	NA	NA	0.11 U	NA
4,4'-DDT	1.1	0.001	0.00022	NA	0.098 U	NA	NA	0.11 U	NA
2,4'-DDE	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
2,4'-DDD	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
2,4'-DDT	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
Total DDD (a,c)	NL	NL	NL	NA	0.098 U	NA	NA	0.11 U	NA
Total DDE (a,d)	NA	NA	NA	NA	0.098 U	NA	NA	0.11 U	NA
Total DDT (a,e)	1.1	0.001	0.000024	NA	0.098 U	NA	NA	0.11 U	NA
ΣDDTs (a,f)	1.1	0.001	NA	NA	0.098 U	NA	NA	0.11 U	NA
PCBs (ug/L)									
Aroclor 1016	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1221	NL	NL	NL	NA	0.39 U	NA	NA	0.11 U	NA
Aroclor 1232	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1242	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1248	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1254	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1260	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1262	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Aroclor 1268	NL	NL	NL	NA	0.20 U	NA	NA	0.11 U	NA
Total PCBs (a,g)	2	0.014	0.000064	NA	0.39 U	NA	NA	0.11 U	NA

Table K-2
TCLT Leachate Chemistry Results Compared to Oregon State Surface Water Quality Criteria

U = Analyte was not detected above the reported sample quantitation limit.
J = Analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ = Analyte was not detected above the reported sample quantitation limit. The reported quantitation limit is approximate.
B = Analyte was positvely identified; the associated numerical value is the approximate concentration of the analyte in the sample.
   The approximate concentration is less than the method report limit but greater than the method detection limit.
NA = No criterion available or compound not analyzed.
NL = Compound not listed.
Box exceeds acute criteria.
Bold box exceeds chronic criteria.
Shaded exceeds water and fish ingestion criteria.

a. Total concentrations are calculated using the detected concentrations of individual constituents. Non-detects are treated as zeros. If all the individual constituents are
   non-detect, the total concentration is reported as non-detect using the highest detection limit.
b. Swartz, 1999, which MacDonald et al., 2000a references as the source of the PAH screening levels, describes
   the total PAH criteria as the sum of the following polycyclic aromatic compounds: naphthalene, acenaphthylene, acenaphthene, fluorene,
   phenanthrene, anthracene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene.
c. The total DDD criteria represent the sum of the following compounds: 2,4'-DDD and 4,4'-DDD.
d. The total DDE criteria represent the sum of the following compounds: 2,4'-DDE and 4,4'-DDE.
e. The total DDT criteria represent the sum of the following compounds: 2,4'-DDT and 4,4'-DDT.
f. ΣDDTs criteria represent the sum of the following compounds: total DDD, total DDE, and total DDT. See footnotes c, d, and e for the definitions
   of total DDD, total DDE, and total DDT, respectively.
g. MacDonald et al., 2000b, which MacDonald et al., 2000a references as the source of the PCB screening levels, does not describe which individual Aroclors make
   up the total PCB criteria. It was assumed that total PCBs consisted of all the Aroclors that were analyzed for (Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor
   1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, Aroclor 1262, and Aroclor 1268).

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Table K-3
Groundwater Flow and Solute Transport Model Input Parameter Values -
Confined Disposal Facility

	Values	Units	Source
Fill Material			
Material description (grain size)	sand and silt		Table 4-2, 4-7 through 4-19
Fraction organic carbon	0.5 to 1.8, avg. 0.8	%	Appendix F
Porosity - sand	0.30 to 0.44		BBL, 2004; Table 4-4
Porosity - silt	0.38 to 0.6		BBL, 2004; Table 4-4
Hydraulic conductivity - sand	1.1E-5 to 7.6E-8	cm/s	Consolidation test results T4-CM2
Hydraulic conductivity - silt	1.4 E-7 to 2.3E-8	cm/s	Consolidation test results T4-GEO1W
Bulk density - sand	1.75 to 2.2	gm/cm^3	BBL, 2004; Table 4-4
Bulk density - silt	1.3 to 2.0	gm/cm^3	BBL, 2004; Table 4-4
COPC concentrations	see Table T_I5B		Appendix F
COPC partition coefficients	see Table T_I5B		Appendix F
COPC degradation rates	Zero		Conservative assumption
Cap Material			
Material description (grain size)	sand		CDF design criteria
Fraction organic carbon	0.1	%	Assumed value for clean sand
Porosity	0.25 to 0.5		Freeze and Cherry, 1979
Hydraulic conductivity	2.8 to 280	ft/day	Freeze and Cherry, 1979
Bulk density	2	gm/cm^3	Based on porosity of 0.40
Berm Material			
Material description (grain size)	well sorted sand and gravel		CDF design criteria
Fraction organic carbon	0.1	%	Assumed value for clean sand and gravel
Porosity	0.25 to 0.50		Freeze and Cherry, 1979
Hydraulic conductivity	280 to 28000	ft/day	Freeze and Cherry, 1979
Bulk density	2.2	gm/cm^3	Calculated based on porosity of 0.3
Aquifer Material and Properties			
Material description (grain size)	sand		BBL, 2004
Fraction organic carbon	0.1	%	Assumed value for clean sand
Porosity	0.25 to 0.50		Freeze and Cherry, 1979
Hydraulic conductivity	65	ft/day	Hart Crowser, 2000
Horizontal hydraulic gradient	0.01	ft/ft	BBL, 2004
Vertical hydraulic gradient	downward 0.04	ft/ft	BBL, 2004
Average groundwater elevation	14	ft CRD	BBL, 2004
River Properties			
Average river stage	5	ft CRD	BBL, 2004
Dimensions			
Berm width top (inside to outside)	10	ft	Conceptual Design C2
Berm width bottom (inside to outside)	276	ft	Conceptual Design C2
Fill material thickness (top to bottom)	36.5	ft	Conceptual Design C2
Fill material length (shore to river)	630 top, 500 bottom	ft	Conceptual Design C2
Cap material thickness	30	ft	Conceptual Design C2
Base of CDF elevation	-35	ft CRD	BBL, 2004
Boundary Flow Conditions			
River - constant head	5	ft CRD	BBL, 2004
Groundwater - constant head	14	ft CRD	BBL, 2004
Annual Precipitation	36.3	inches	www.worldclimate.com
Recharge Through Cap	22.3 unpaved, 0.92 paved	in/yr	Estimated using HELP model
Dispersivity			
Longitudinal dispersivity	18 to 60	ft	per Gelhar, 1992
Horizontal dispersivity	1.8 to 6	ft	per Gelhar, 1992
Vertical dispersivity	0.18 to 0.6	ft	per Gelhar, 1992

Table K-4
Groundwater Flow and Solute Transport Model Constituents of Potential Concern

METALS

COPC	Maximum Detected TCLT Eluent Concentration (μg/L)	Average Detected Concentration (μg/L)	Minimum TCLT Partition Coefficient, K_d (L/kg)	Maximum TCLT Partition Coefficient, K_d (L/kg)	Lowest Applicable Criterion (μg/L)	Groundwater Maximum Detected Concentration (μg/L)[b]	Groundwater Average Detected Concentration (μg/L)[b]	Groundwater Minimum Detected Concentration (μg/L)[b]
Arsenic	4.1	2.9	610	879	0.018	7.4	7.4	7.4
Cadmium	0.21	0.1	1429	2880	0.094	0.74	0.21	0.09
Copper	13.3	6.7	1,729	8,691	2.7	2.13	2.13	2.13
Lead	5.8	2.7	4,021	10,100	0.54	0.26	0.26	0.26

ORGANIC COMPOUNDS

COPC	Maximum Detected TCLT Eluent Concentration (μg/L)	Average TCLT Eluent Concentration (μg/L) - Includes Non-Detects	Minimum TCLT Partition Coefficient, K_d (L/kg)	Minimum TCLT Partition Coefficient[a], K_{oc} (L/kg)	Maximum TCLT Partition Coefficient, K_d (L/kg)	Maximum TCLT Partition Coefficient[a,e], K_{oc} (L/kg)	Lowest Applicable Criterion (μg/L)	Groundwater Maximum Detected Concentration (μg/L)[d]	Groundwater Average Concentration (μg/L)[c,d]	Groundwater Minimum Detected Concentration (μg/L)[d]
Chrysene	0.034 J	0.4 U	1,927	240,875	20,294	2,536,750	0.0028	0.024	0.010	0.0041
4,4'-DDE[e]	0.0054 J	0.1 U	23	2,875	389	48,625	0.00022	ND	ND	ND

Notes:

(a) K_{oc} based on sediment organic carbon fraction of 0.8%.

(b) Based on data for T4S1-MW11-GW-1 from Hart Crowser, 2004.

(c) Based on groundwater data from 4 wells and two soil borings along head of Slip 1 from Hart Crowser, 2004).

(d) Non-detects assigned a value of 1/2 detection limit for calculating average concentration.

(e) The K_d value for 4,4'-DDE was based on non-detects and one J-qualified detection. Since the predicted K_{oc} was well below literature -based values, a literature-based K_{oc} value of 155,000 L/kg was used for 4,4'-DDE. [Fetter, 1994. Applied Hydrogeology. Prentice Hall, Englewood Cliffs, NJ.]

COPC - Constituent of potential concern

ND - not detected

Table K-5
Groundwater Flow and Solute Transport Model Base Case Scenario -
Confined Disposal Facility

	Units	Base Case Scenario - Sand Fill
Fill Material		
Material description (grain size)		sand
Fraction organic carbon	%	0.8
Porosity		0.35
Hydraulic conductivity	ft/day	1.05E-03
Bulk density	gm/cm^3	2.1
COPC concentrations		COPC-specific - see Table X
COPC partition coefficients		COPC-specific - see Table X
COPC degradation rates		COPC-specific - see Table X
Cap Material		
Material description (grain size)		sand
Fraction organic carbon		0.10%
Porosity		0.4
Hydraulic conductivity	ft/day	28
Bulk density	gm/cm^3	2
Berm Material		
Material description (grain size)		well sorted sand and gravel
Fraction organic carbon		0.10%
Porosity		0.3
Hydraulic conductivity	ft/day	2800
Bulk density	gm/cm^3	2.2
Aquifer Material and Properties		
Material description (grain size)		sand
Fraction organic carbon		0.10%
Porosity		0.3
Hydraulic conductivity	ft/day	65
Horizontal hydraulic gradient	ft/ft	0.01
Vertical hydraulic gradient	ft/ft	0.04
Average groundwater elevation	ft CRD	14
River Properties		
Average river stage	ft CRD	5
Dimensions		
Berm width top (inside to outside)	ft	10
Berm width bottom (inside to outside	ft	276
Fill material thickness (top to bottom	ft	36.5
Fill material length (shore to river)	ft	630 top, 500 bottom
Cap material thickness	ft	30
Bottom of CDF elevation	ft CRD	-35
Boundary Flow Conditions		
River - constant head	ft CRD	5
Groundwater - constant head	ft CRD	14
Annual Precipitation	inches	36.3
Recharge Through Cap	in/yr	0.92
Dispersivity		
Longitudinal dispersivity	ft	60
Horizontal dispersivity	ft	6
Vertical dispersivity	ft	0.6

Table K-6
Groundwater Flow and Solute Transport Model Base Case Scenario Results

Base Case Scenario for Sandy Fill Material

| Constituent | Modeled CoPC Concentrations | | | | | | Lowest Applicable Criterion[a] |
| | Berm Outside | | | Berm Inside | | | |
	Bottom	Middle	Top of Fill	Bottom	Middle	Top of Fill	
Arsenic	$<10^{-8}$	$<10^{-8}$	$<10^{-8}$	*1.29*	*1.68*	*2.62*	0.018
Cadmium	$<10^{-8}$	$<10^{-8}$	$<10^{-8}$	0.067	0.063	0.081	0.094
Copper	$<10^{-8}$	$<10^{-8}$	$<10^{-8}$	*5.09*	*3.37*	*8.07*	2.7
Lead	$<10^{-8}$	$<10^{-8}$	$<10^{-8}$	*2.48*	*2.38*	*3.8*	0.54
Chrysene	$<10^{-8}$	$<10^{-8}$	$<10^{-8}$	0.0015	0.0017	0.0025	0.0028
4,4'-DDE	$<10^{-8}$	$<10^{-8}$	$<10^{-8}$	*0.0024*	*0.0024*	*0.0024*	0.00022

NOTES:

All concentrations in ug/L

Model initial concentrations set as maximum detected concentration

Minimum TCLT partitition coefficient used in model

Bolded and italized values indicate exceedance of lowest applicable criterion

[a] At request of USEPA and the Tribes, other water quality screening values based on tribal fish consumption rates are shown in Attachment K-3.

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EXISTING CONDITIONS AT
SLIP 1, TERMINAL 4

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FIGURE

K-1

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CDF CONCEPT

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FIGURE

K-2
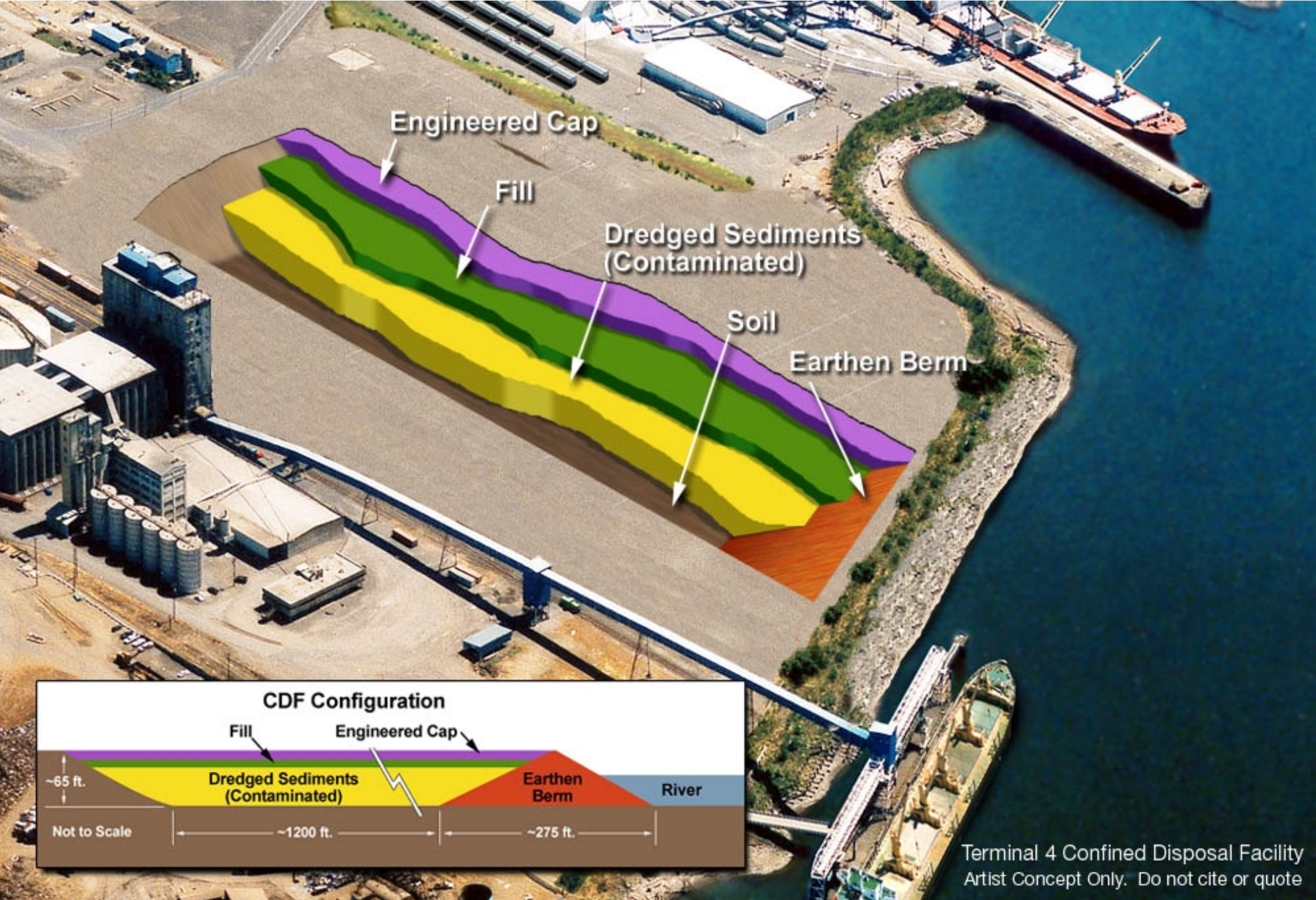
Engineered Cap

Fill

Dredged Sediments
(Contaminated)

Soil

Earthen Berm

CDF Configuration

Fill   Engineered Cap

~65 ft.

Dredged Sediments
(Contaminated)

Earthen
Berm

River

Not to Scale   ~1200 ft.   ~275 ft.

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TYPICAL CROSS SECTION THROUGH
THE PROPOSED CDF

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FIGURE

K-3

Training Terraces
Consisting of Quarry Spalls
or Riprap (Typical)

Low-Permeability Asphalt Pavement

CDF SAND CAP

FILL

UPLAND FILL
(Medium Sand)

DREDGED SEDIMENT

HEAD OF SLIP 1

2
1

CDF BERM
(SELECT FILL)

2
1

NATIVE SOIL
(Silt and Silty Sand)

Overexcavate Soft Sediments
and Replace with Select Fill

Existing Mudline

Approx. Top of T4
Dredged Sediment Fill

ALLUVIAL SAND

Elevation in Feet (CRD)

50

0

-50

-100

Elevation in Feet (CRD)

50

0

-50

-100

Scale in Feet

0   50   100

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ASSUMED CDF CONFIGURATION

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FIGURE

K-4

Liquefaction Analyses were Performed at These Locations

(A) (B) (C)

Elevation in Feet (CRD)

50
0
-100

CDF BERM

$S_r = 350\,psf$
$S_r = 600\,psf$

$(N_1)_{60,\,avg.} \simeq 12$
$(N_1)_{60,\,avg.} \simeq 16$

Assumed Extent of Liquefaction

ALLUVIAL SAND

FS < 1.0
(Liquefaction)

FS = 0.9 to 1.2
(marginal FS: assumed liquefaction)

Analysis indicated: No liquefaction

CONTINGENCY LEVEL EVENT (CLE)

Liquefaction Analyses were Performed at These Locations

(A) (A.5) (B) (C)

Elevation in Feet (CRD)

50
0
-50
-100

CDF BERM

$S_r = 350\,psf$
$S_r = 600\,psf$

$(N_1)_{60,\,avg.} \simeq 12$
$(N_1)_{60,\,avg.} \simeq 16$

Assumed Extent of Liquefaction

FS = 1.3 to 1.6
(assumed: no liquefaction)

ALLUVIAL SAND

FS < 1.0
(Liquefaction)

FS = 1.0 to 1.2
(marginal FS: assumed liquefaction)

Analysis indicated: No liquefaction
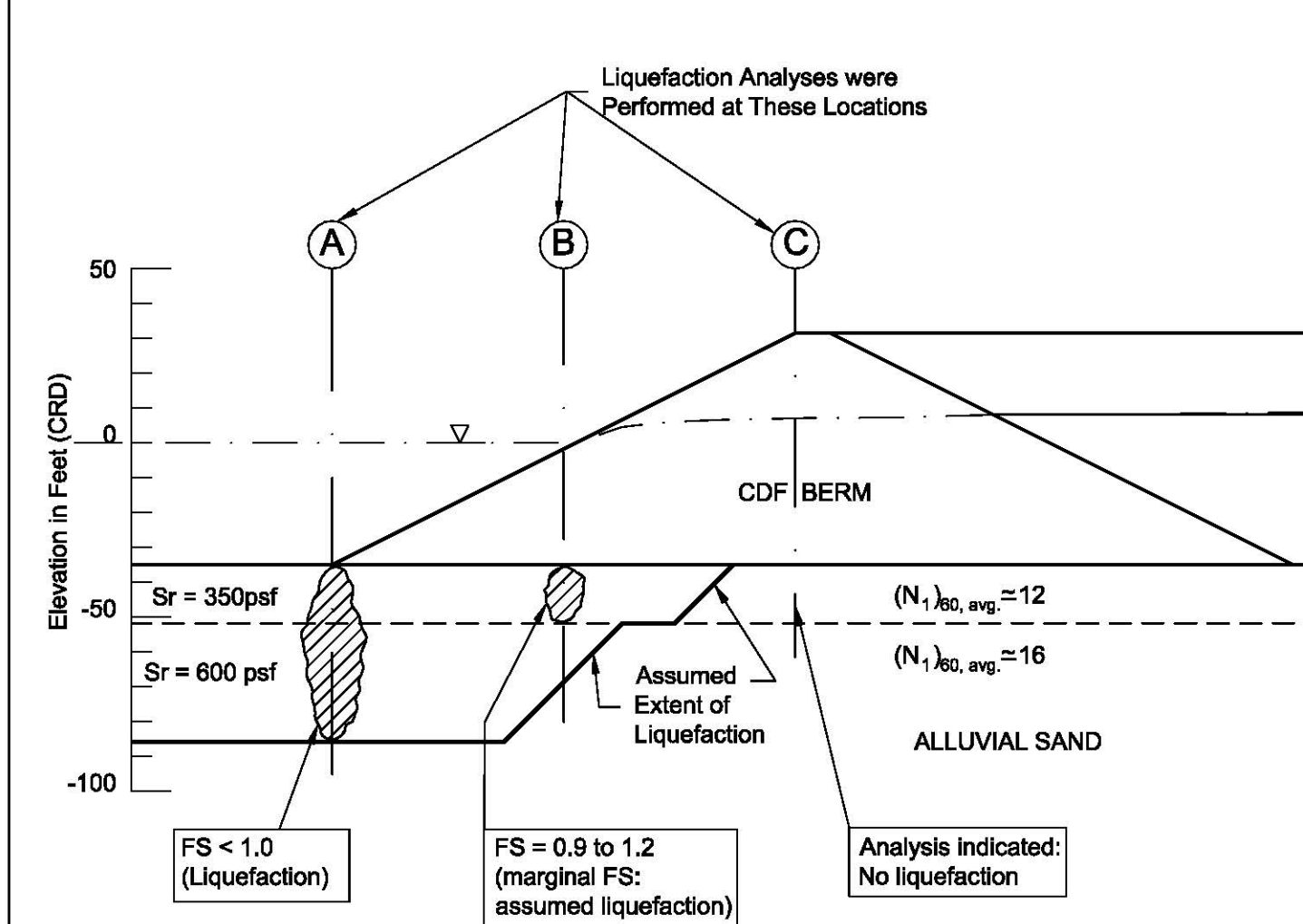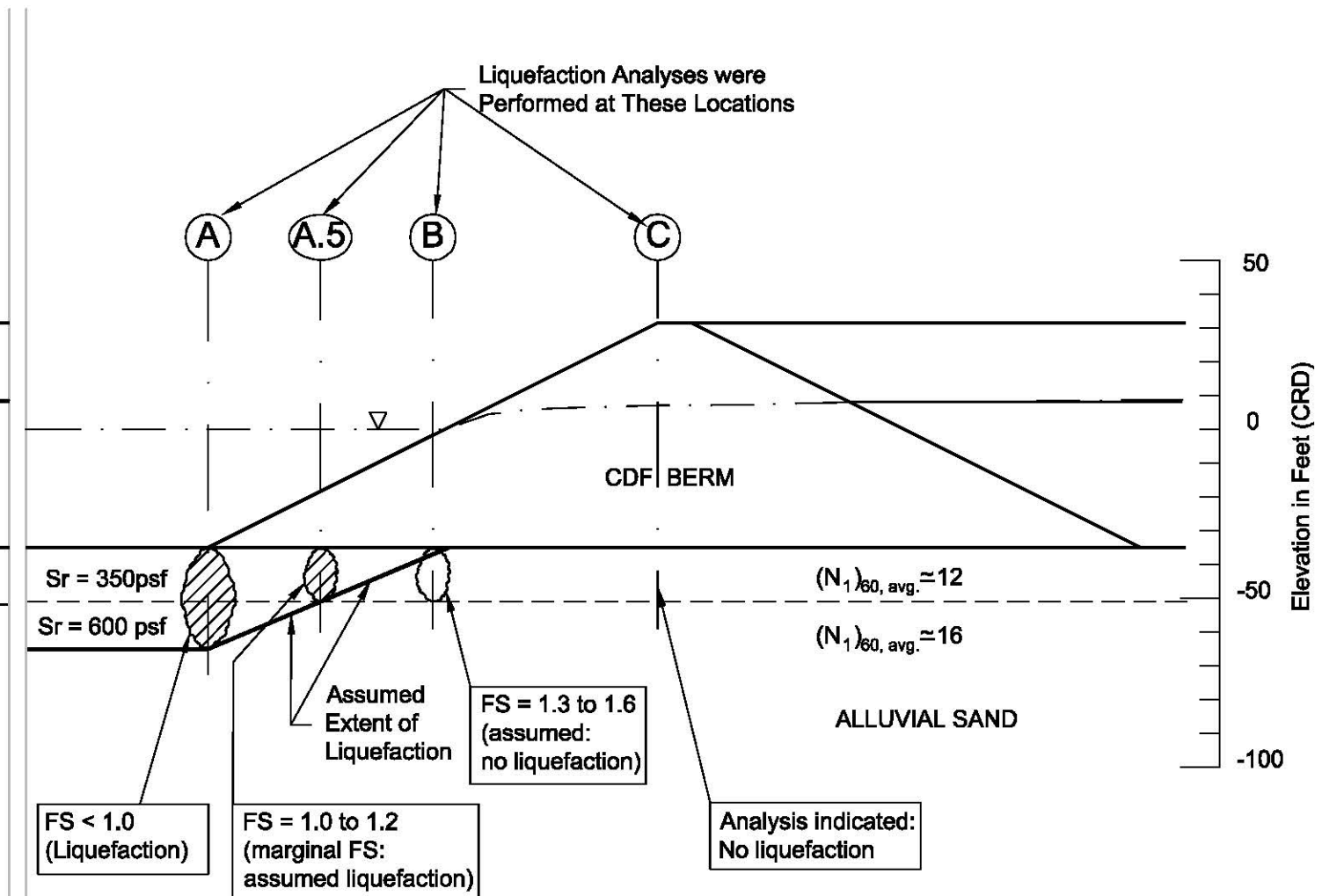
OPERATING LEVEL EVENT (OLE)

LEGEND:

FS   Factor of Safety (Liquefaction)

Sr   Residual Shear Strength

$(N_1)_{60,\,avg.}$ Average Corrected Blow Count / N Value
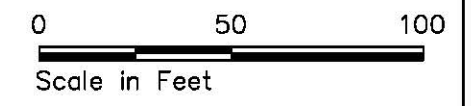
0   50   100
Scale in Feet

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RESULTS OF
LIQUEFACTION ANALYSIS

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FIGURE
K-5
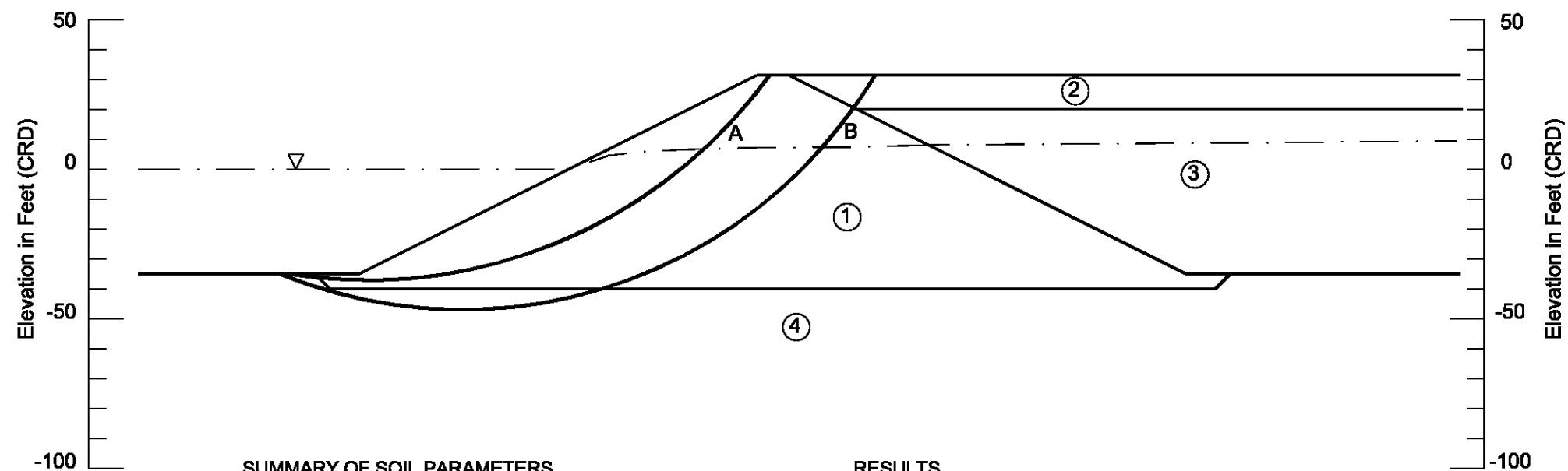
SUMMARY OF SOIL PARAMETERS

SOIL UNIT	DESCRIPTION	UNIT WEIGHT IN PCF	FRICTION ANGLE IN DEGREES
①	SELECT FILL	135	35
②	SELECT FILL	130	37
③	SILTY SAND	115	30
④	SAND (ALLUVIUM)	120	32

RESULTS

CONDITION	FACTOR OF SAFETY	TYPICAL SLIP SURFACE
STATIC	1.2 [1]	A
STATIC	1.5	B

[1] Minimum factor of safety for this condition
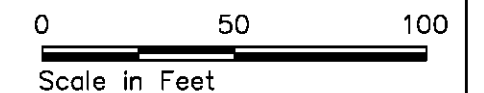
Scale in Feet

0   50   100

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BERM STABILITY ANALYSIS RESULTS
LONG-TERM STATIC ANALYSES

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FIGURE
K-6
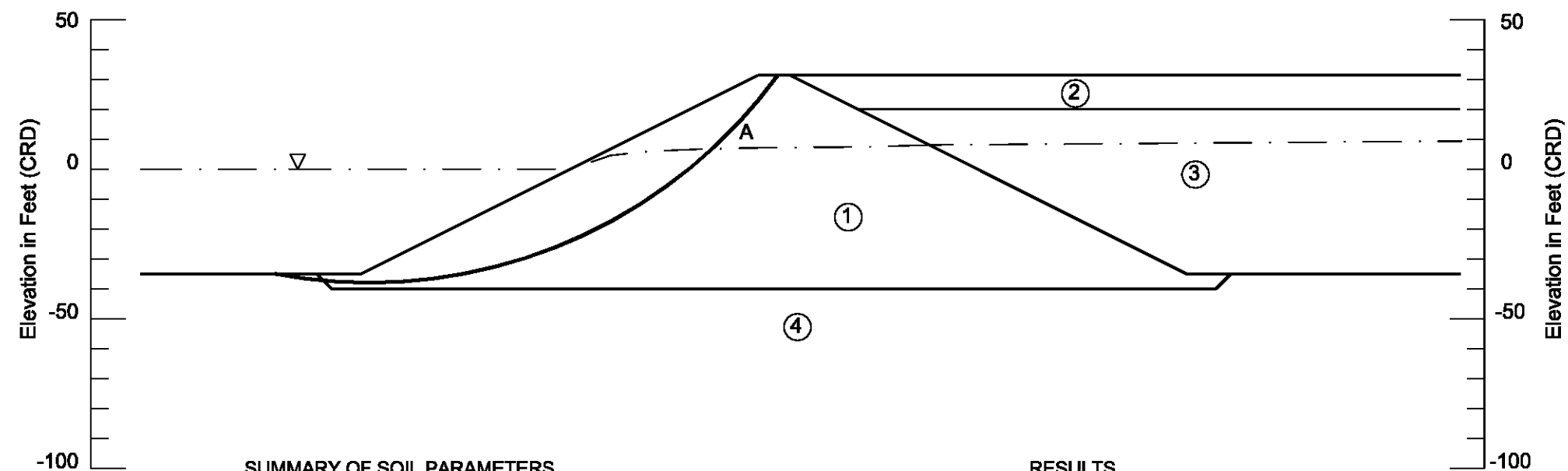
SUMMARY OF SOIL PARAMETERS

SOIL UNIT	DESCRIPTION	UNIT WEIGHT IN PCF	FRICTION ANGLE IN DEGREES	UNDRAINED STRENGTH IN PSF
①	SELECT FILL	135	35	NA
②	SELECT FILL	130	37	NA
③	SILTY SAND	115	NA	400
④	SAND (ALLUVIUM)	120	32	NA

RESULTS

CONDITION	FACTOR OF SAFETY	TYPICAL SLIP SURFACE
CLE (PSEUDOSTATIC)	1.0 [1]	A
OLE (PSEUDOSTATIC)	1.1 [1]	A

[1] Minimum factor of safety for this condition

0   50   100

Scale in Feet

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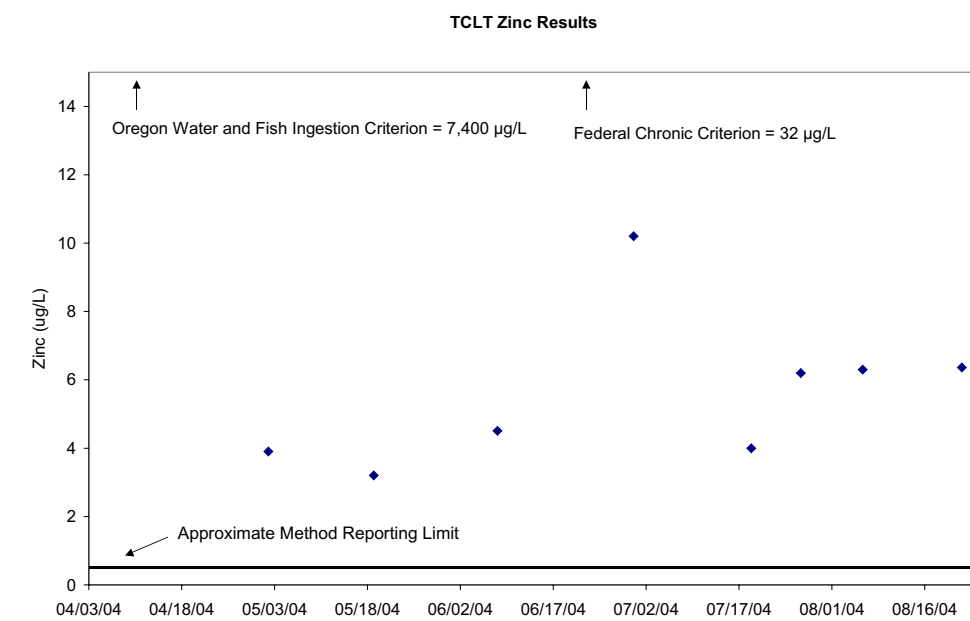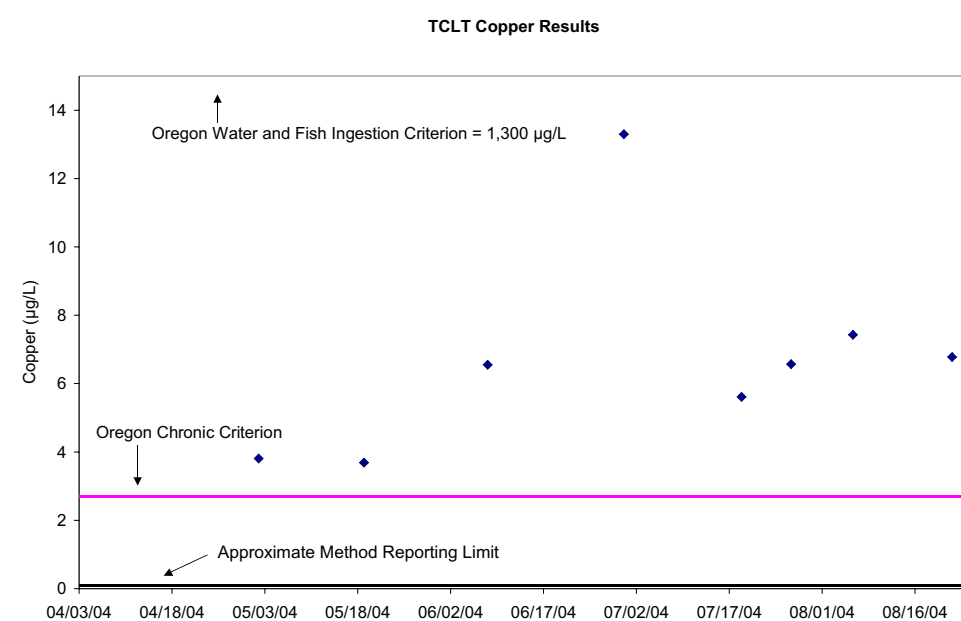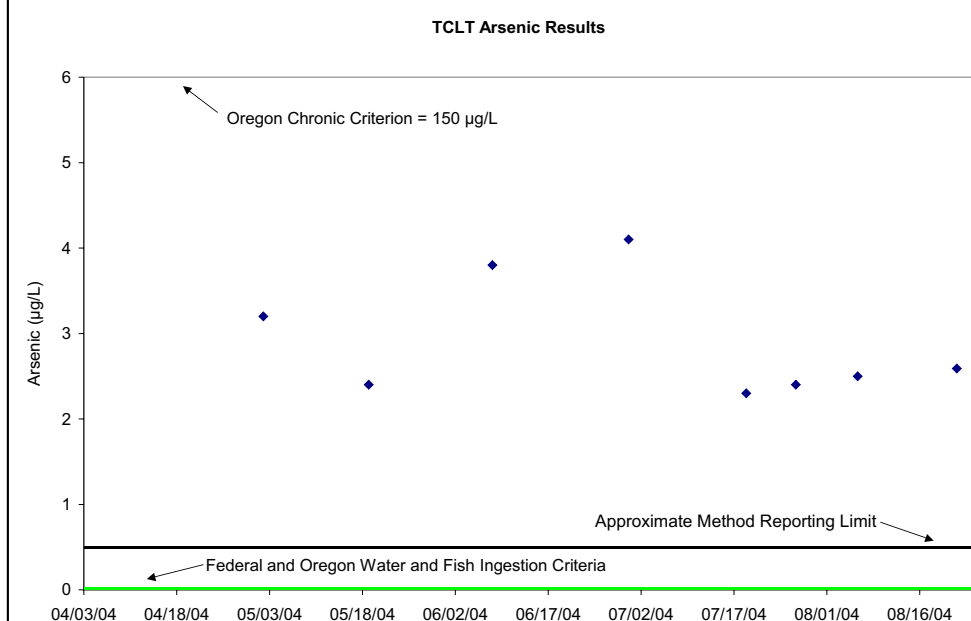BERM STABILITY ANALYSIS RESULTS
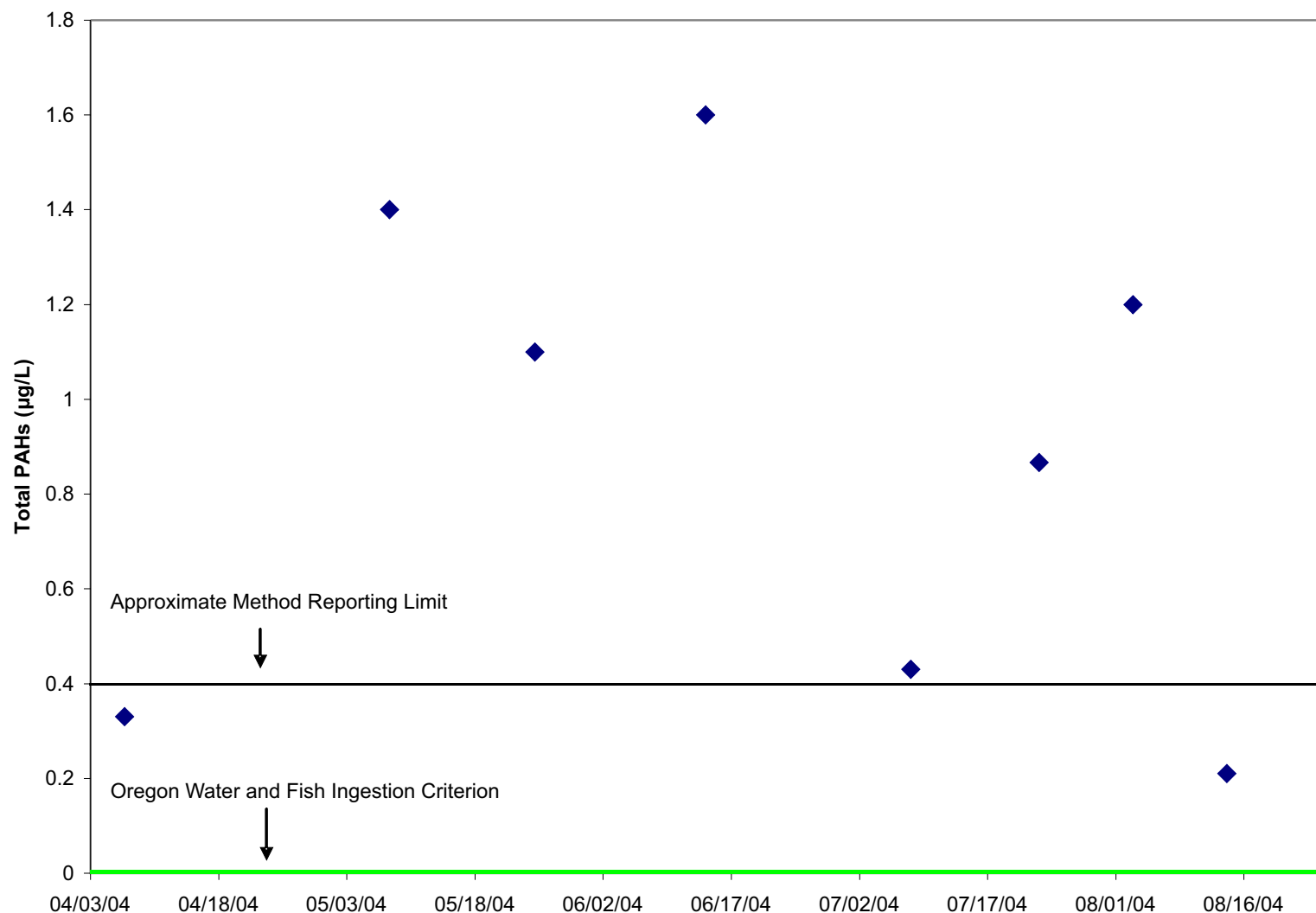PSEUDOSTATIC ANALYSES (CLE & OLE)

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FIGURE
K-7

CONTINGENCY LEVEL EVENT (CLE)

OPERATING LEVEL EVENT (OLE)
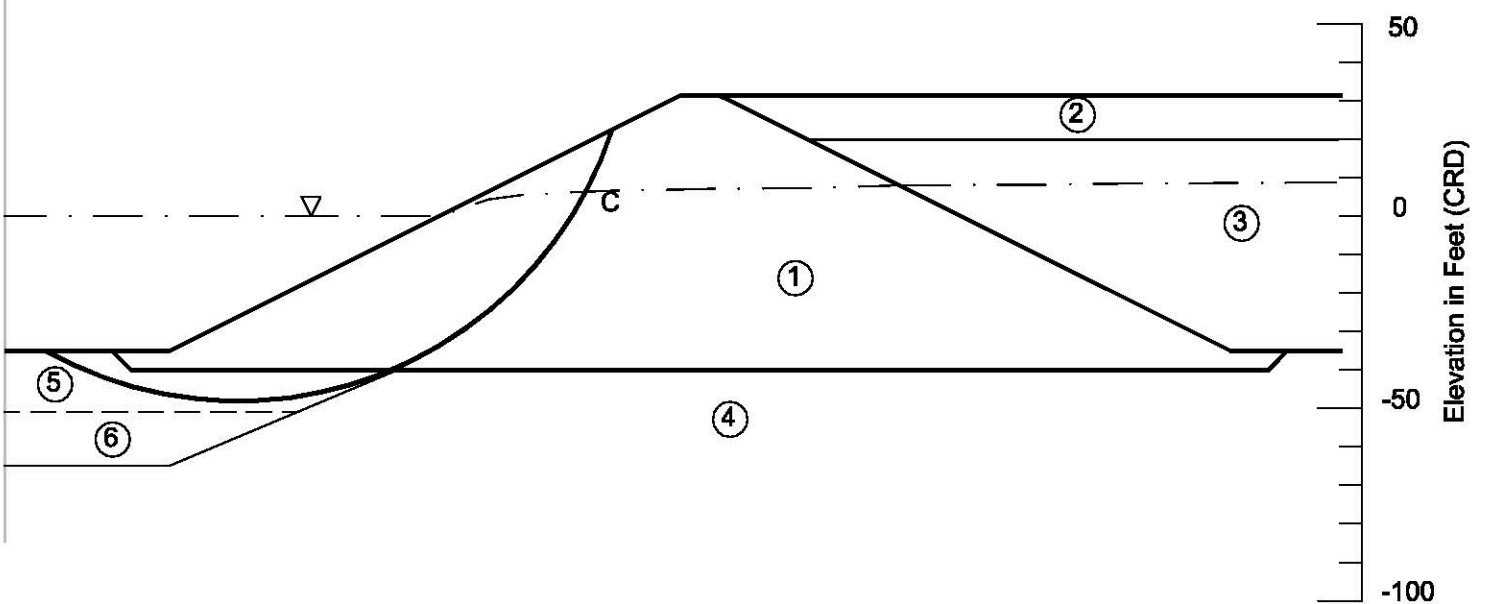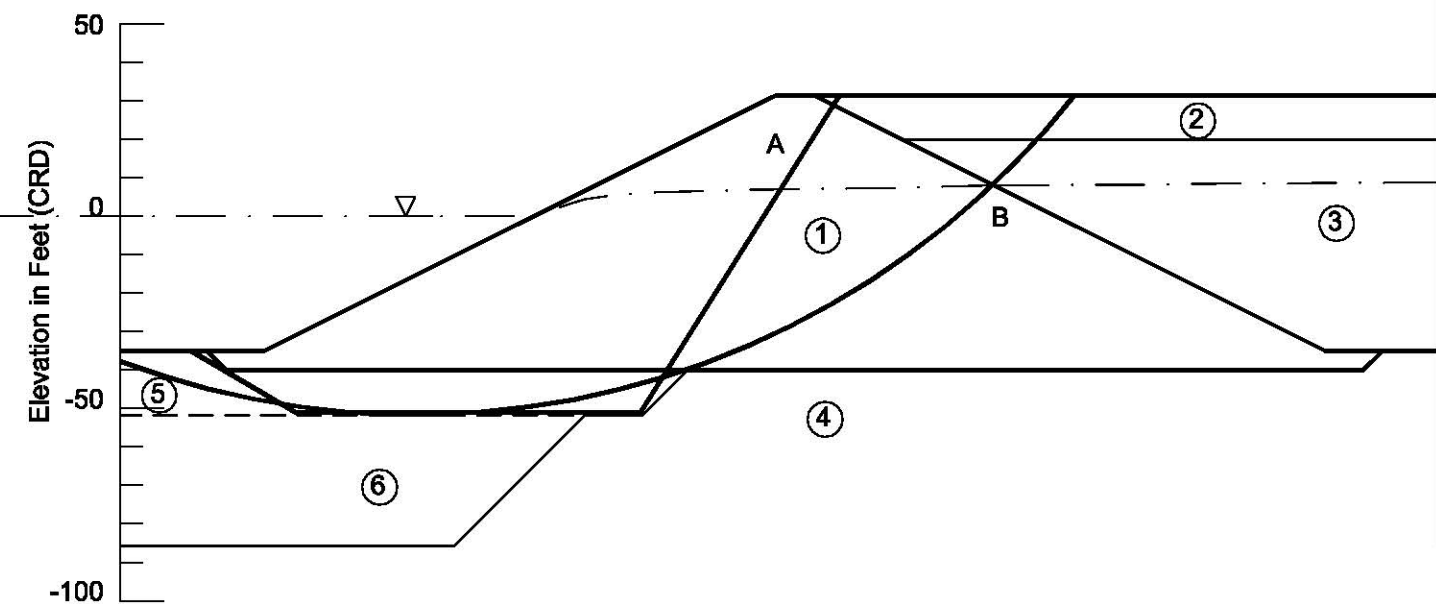
SUMMARY OF SOIL PARAMETERS

SOIL UNIT	DESCRIPTION	UNIT WEIGHT IN PCF	FRICTION ANGLE IN DEGREES	UNDRAINED STRENGTH IN PSF
①	SELECT FILL	135	35	NA
②	SELECT FILL	130	37	NA
③	SILTY SAND	115	NA	150
④	SAND (ALLUVIUM)	120	32	NA
⑤	SAND (ALLUVIUM)	120	NA	350
⑥	SAND (ALLUVIUM)	120	NA	600

RESULTS

CONDITION	FACTOR OF SAFETY	TYPICAL SLIP SURFACE
CLE (POST-EARTHQUAKE)	<1.0 [1]	A
CLE (POST-EARTHQUAKE)	1.0	B
OLE (POST-EARTHQUAKE)	1.0 [1]	C

[1] Minimum factor of safety for this condition
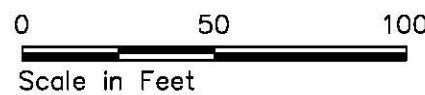
Scale in Feet
0   50   100

PORT OF PORTLAND
PORTLAND, OREGON
TERMINAL 4 EARLY ACTION
EE/CA REPORT

BERM STABILITY ANALYSIS RESULTS
POST-EARTHQUAKE ANALYSES
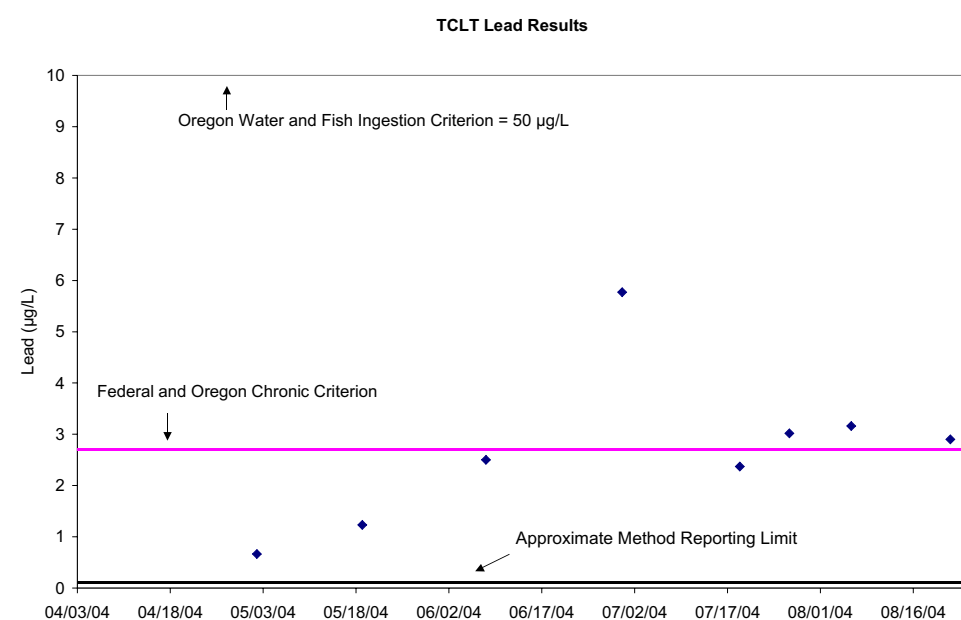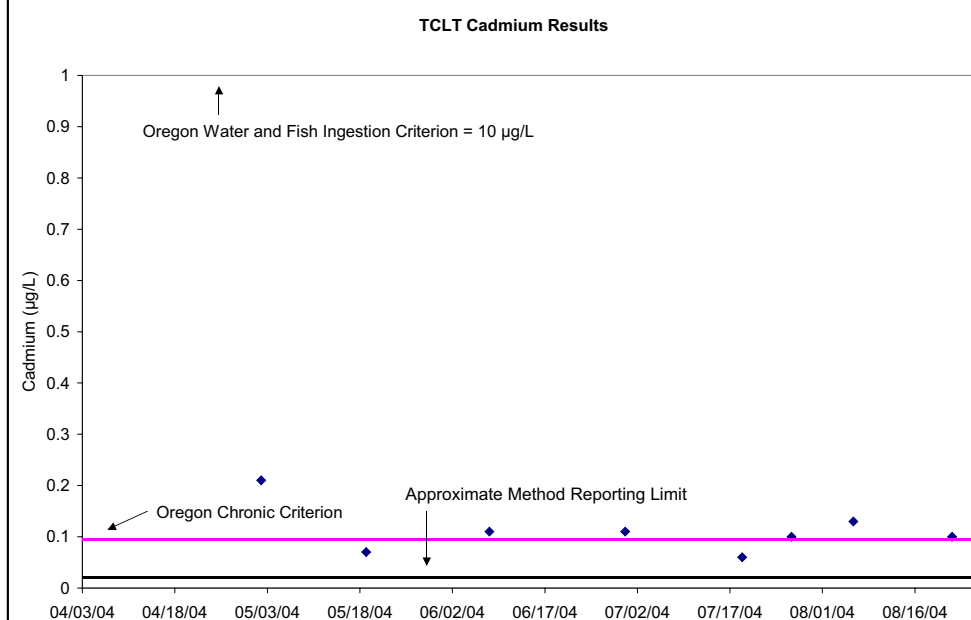
BBL
BLASLAND, BOUCK & LEE, INC.
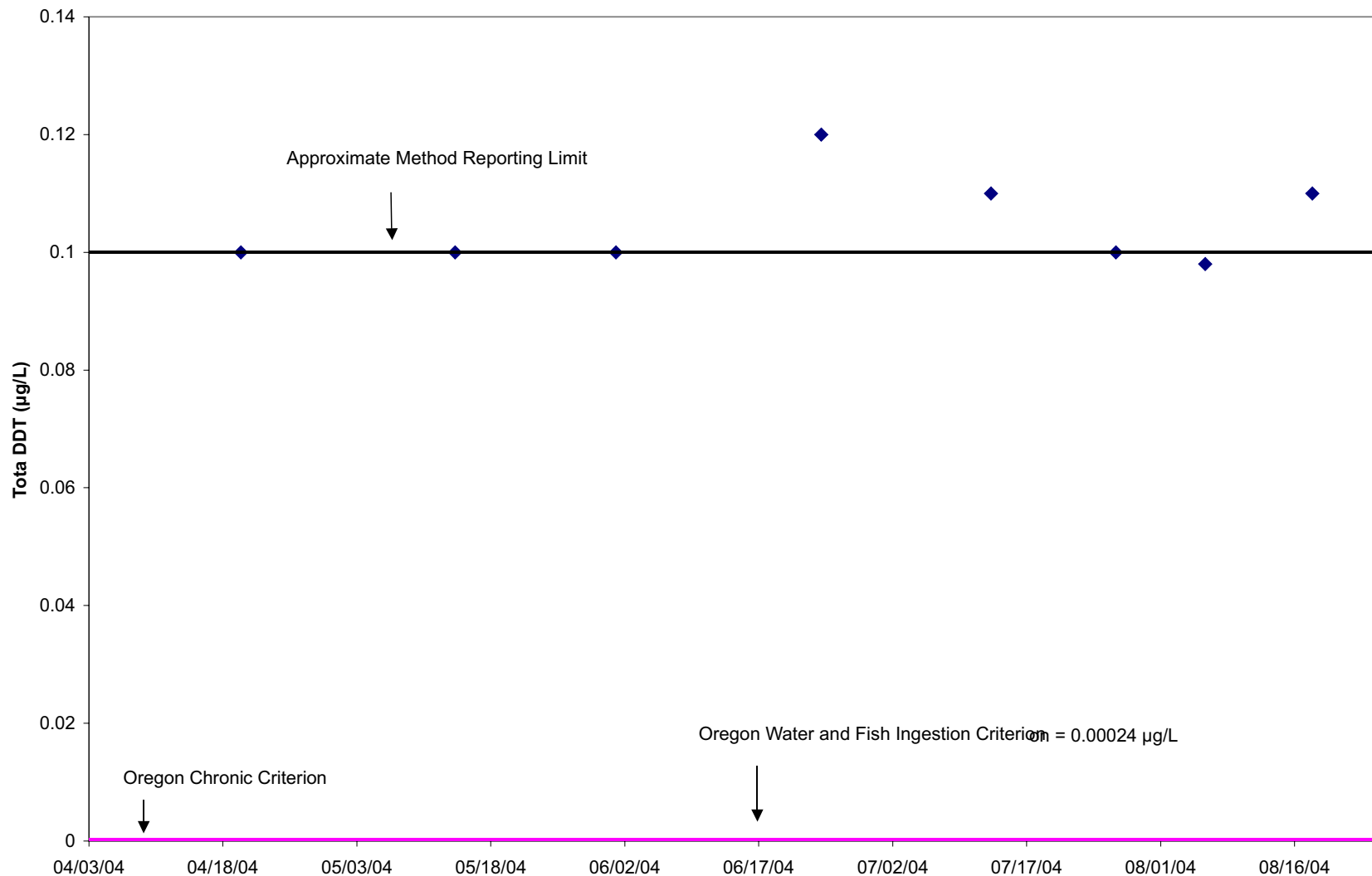engineers & scientists

FIGURE
K-8

DRAFT DOCUMENT
Do Not Quote or Cite. This document is
currently under review by US EPA and its
federal, state and tribal partners, and is subject
to change in whole or in part.

TCLT Arsenic Results

TCLT Copper Results

TCLT Zinc Results

TCLT Cadmium Results
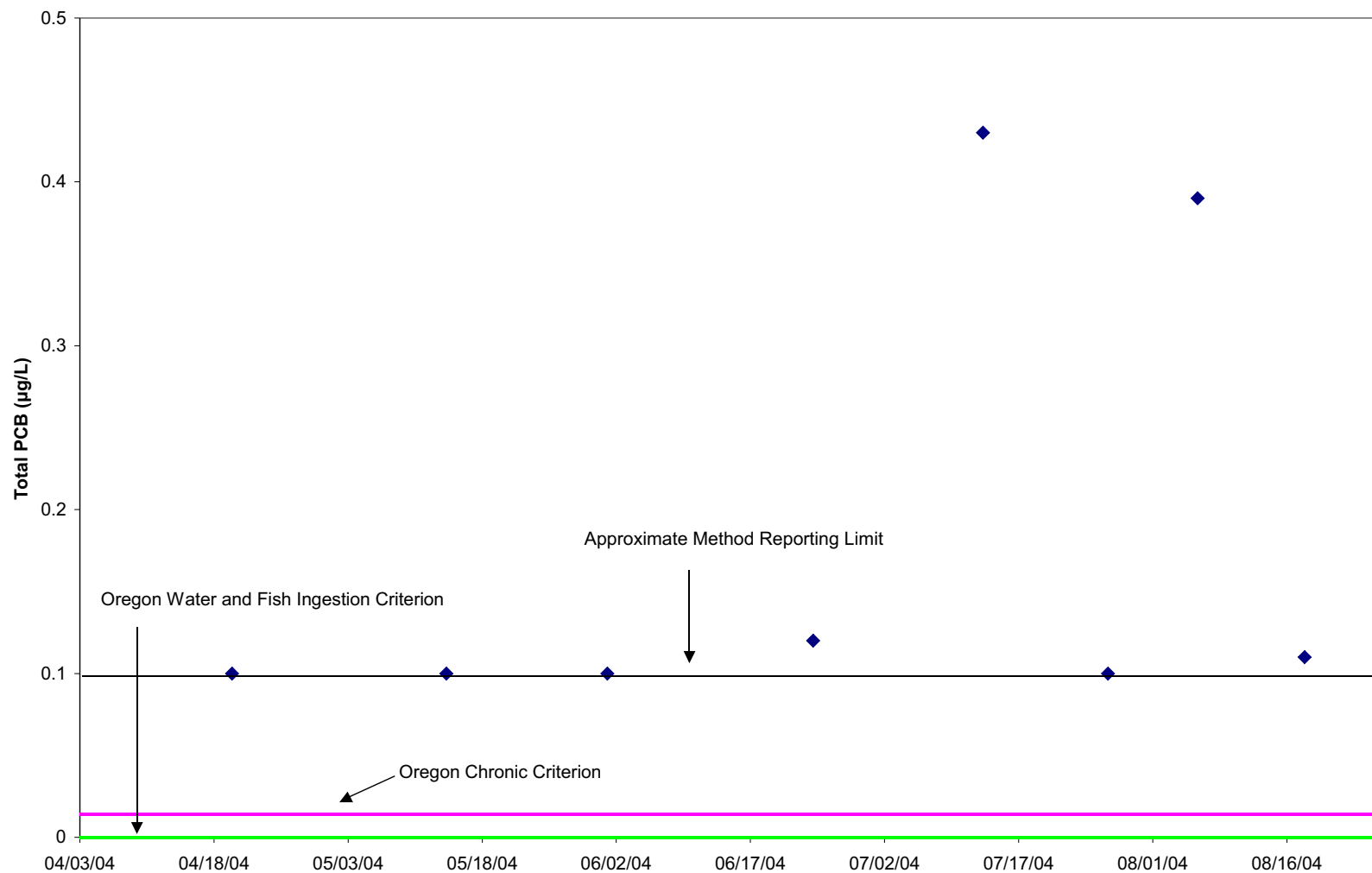
TCLT Lead Results

DRAFT DOCUMENT

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TERMINAL 4 EARLY ACTION
EE/CA REPORT

TCLT METAL CONCENTRATIONS
WITH TIME

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engineers & scientists

FIGURE
K-9

FIGURE

K-10

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TERMINAL 4 EARLY ACTION
EE/CA REPORT

TCLT TOTAL PAH CONCENTRATIONS
WITH TIME

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0.14

0.12

Approximate Method Reporting Limit

0.1

Tota DDT (µg/L)

0.08

0.06

0.04

0.02

Oregon Water and Fish Ingestion Criterion = 0.00024 µg/L

Oregon Chronic Criterion

0

04/03/04   04/18/04   05/03/04   05/18/04   06/02/04   06/17/04   07/02/04   07/17/04   08/01/04   08/16/04

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TCLT TOTAL DDT CONCENTRATIONS
WITH TIME

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FIGURE

K-11

Total PCB (µg/L)

Approximate Method Reporting Limit

Oregon Water and Fish Ingestion Criterion

Oregon Chronic Criterion

PORT OF PORTLAND
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TERMINAL 4 EARLY ACTION
EE/CA REPORT

TCLT TOTAL PCB CONCENTRATIONS
WITH TIME

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FIGURE

K-12

Attachment K-1

Technical Memo/Letter by Parsons Brinckerhoff on Flood Stage Assessment

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engineers, scientists, economists

March 11, 2005

Anne Summers
Port of Portland
121 NW Everett
Portland, OR 97209

Dear Anne:

It is our understanding that the Port of Portland (Port) is under an Administrative Order on Consent (AOC) with the U.S. Environmental Protection Agency (EPA) to perform a removal action at the Port's Terminal 4 (T-4) site pursuant to the Comprehensive Environmental Response & Liability Act (CERCLA). T-4 is included in the Initial Study Area of the Portland Harbor Superfund Site. The Port submitted a preliminary Draft Engineering Evaluation/Cost Analysis (EE/CA) for EPA's review on January 26, 2005. The Draft EE/CA evaluates and ranks four alternatives for the removal action against EPA's criteria and preliminarily identifies a preferred alternative. As requested, Parsons Brinckerhoff (PB) has analyzed the potential floodplain impact of the preferred alternative at the Port's T-4 site, which is located on the right (north) overbank of the Willamette River between River Miles (RM) 4.2 and RM 4.8. The preferred alternative includes an at-grade confined disposal facility (CDF) in Slip 1, dredging in Slip 3 and capping at multiple locations, including a small area in the northeast corner of Berth 401, portions of the slope at Wheeler Bay, under the pier at Berth 411 and the nearshore slopes around Slip 3 (hereinafter "proposed removal action").

Under Federal Emergency Management Agency (FEMA) criteria, a planned development, in conjunction with existing and anticipated development, must not cause any rise to occur at any location, relative to the existing 100-year floodway elevations. To fulfill the 'no-rise' criteria, PB developed two hydraulic computer models. The first model represents the existing condition and establishes the existing 100-year floodplain and floodway elevations. The second model, termed the proposed condition, incorporates the proposed removal action into the existing condition model to determine the potential impacts.

This transmittal provides a description of the methodology and results for the hydraulic modeling efforts.

Background
The effective FEMA Flood Insurance Study (FIS) of the Willamette River for the City of Portland, Oregon is dated October 19, 2004. T-4 is located on the effective FEMA Flood Insurance Rate Maps (FIRM) panel number 4101830060E, for the City of Portland, dated October 19, 2004. As shown on the FIRM, the Willamette River is delineated as Zone AE in the vicinity of the project site with base flood elevations and a floodway determined.

While the FIS and FIRM are dated 2004, the hydraulic computer model used to develop the FIS and FIRM has not been updated since the U.S. Army Corps of Engineers (USACE) developed the Willamette River hydraulic model in 1979. A telephone conversation with Dave Carlton, FEMA Region X engineer, on November 24, 2004, confirmed that the current FIS did not update the computer model of the Willamette River.

The 2004 FIS and FIRM update did shift the vertical datum used to report flood elevations. The previous standard vertical datum for FIS and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD); however, recent updates are using the newly adopted standard vertical datum of the North American Vertical Datum of 1988 (NAVD). The conversion factor from NGVD to NAVD is +3.5 feet. For example, 27 feet NGVD corresponds to 30.5 feet NAVD. As the hydraulic computer model had not been updated since 1979, the vertical datum used in the FIS model was NGVD, and this modeling effort has maintained the use of NGVD.

Conceptual Design
The proposed conceptual designs for the CDF, dredging and capping at T-4 have been developed by Blasland, Bouck & Lee (BBL) and the Port, and the design details are considered preliminary. The conceptual CDF design includes construction of an earthen berm at the mouth of Slip 1 to isolate proposed dredged material placement within the slip. The toe of the earthen berm extends slightly beyond the mouth of Slip 1 into the river channel but not beyond the harbor line or floodway boundary. As the conceptual CDF berm would not encroach within the floodway, the CDF would not impact floodway elevations.

While dredging is proposed within Slip 3 as a part of the conceptual design, the proposed dredging represents a single event and is not a part of the Port's ongoing maintenance dredging program. Based upon discussions with Port of Portland personnel, the Port intends to continue its current practice of maintaining Slip 3 to at least -40 feet CRD (-38.3 feet NGVD), as required by the Port's lease with tenant Kinder Morgan. As such, the hydraulic models developed reflect the currently maintained depth of -38.3 feet NGVD in Slip 3

Capping is proposed at multiple locations in T-4 including a small area in the northeast corner of Berth 401, portions of the slope at Wheeler Bay, under the pier at Berth 411 and the nearshore slopes around Slip 3. Comparing the conceptual plans with the FIRM map indicates that minor floodway encroachments may occur from the capping at Berth 401 and at the upstream end of Slip 3. However, the capping at Wheeler Bay does not encroach within the floodway. While it is likely possible that future capping design refinements could avoid floodway encroachments, the hydraulic modeling performed included the floodway encroachments due to capping as shown in the existing conceptual design. Based on information from BBL, the preliminary capping thickness is three feet at Berth 401 and Wheeler Bay and three to four feet at Slip 3.

HEC-RAS Model
Developed by the USACE Hydrologic Engineering Center and adopted by FEMA, the River Analysis System (HEC-RAS) is a step-backwater one-dimensional hydraulic computer program that is used to estimate flood elevation profiles along a waterway for a given set of circumstances. The Willamette River hydraulic model was developed using HEC-RAS version 3.1.2, which was released April 2004. Input to the HEC-RAS model includes the channel geometry of the river, flood event flows, and initializing boundary conditions such as the downstream water surface elevations or critical water depth.

The channel geometry of the lower Willamette River was represented by cross-sections taken from the 1979 FIS hydraulic model and 2003 hydrographic survey data provided by BBL. Oriented looking downstream in the direction of flow, the cross-sections extend from the left (south) overbank, across the river to the right (north) overbank.

The HEC-RAS model was run for the 100-year flood event and floodway using the flows specified in the currently effective Willamette River FIS. In addition, the downstream water surface elevations utilized the flood elevations provided in the currently effective Willamette River FIS.

Currently Effective FIS Modeling
The currently effective 1979 FIS model for the Willamette River was developed using the computer program HEC-2, which was a precursor to HEC-RAS. In order to verify the FIS floodway widths and elevations, PB imported the existing FIS HEC-2 model data of the Willamette River into HEC-RAS.

From the mouth of the Willamette River upstream past the Burlington Northern Railroad Bridge (cross-section 7.68), the FIS HEC-RAS model output replicated the 100-year floodplain and floodway elevations in the FIS Floodway Data Table. The FIS HEC-RAS model also reproduced the floodway widths and velocities specified in the FIS Floodway Data Table.

Existing Condition HEC-RAS Modeling
To represent the existing condition, the hydraulic analysis developed a computer model of the Willamette River, starting at RM 0.38 and extending upstream of T-4 to RM 7.68. Data from the 1979 Willamette River FIS model were utilized for 14 of the cross-sections. An additional ten cross-sections were located in the vicinity of the project site: cross-sections 4.25, 4.26, 4.27, 4.34, 4.43, 4.6, 4.68, 4.74, 4.75 and 4.8. Figure 1 provides the cross-section locations for the existing condition model and the project site features (attached).

As shown in Figure 1, new cross-sections at RM 4.43 and RM 4.68 were added to incorporate the T-4 Slips 1 and 3, respectively, into the hydraulic model. Additional cross-sections were added to reflect the proposed capping at RM 4.25, 4.26, and 4.27 for Berth 401, RM 4.6 for Wheeler Bay, and RM 4.74 and 4.75 for Slip 3. New cross-sections were also added at RM 4.34 (downstream of Slip 1) and RM 4.8 (upstream of Slip 3) to provide transition.

Due to past dredging practices in the vicinity of T-4, the hydrographic survey indicates deeper channel depths than the FIS model. The existing water depths in excess of -60 and -70 feet NGVD would not be maintained through dredging. In order to reflect the long-term channel condition, the channel geometries from FIS cross-sections 4.54 and 5.0 were used to develop the new cross-sections. Ineffective flow areas were defined within T-4 Slips 1 and 3 because the slips would not convey floodwaters during an event.

Proposed Condition HEC-RAS Modeling
Once the existing condition HEC-RAS model was completed and checked, it served as the basis for the proposed condition HEC-RAS model. The proposed condition model incorporated the proposed CDF at cross-

section 4.43, the capping at Berth 401 at cross-section 4.26, the capping at Wheeler Bay at cross-section 4.6 and the capping at Slip 3 at cross-section 4.75 into the existing condition model to estimate the potential impacts.

100-year Floodplain Results
Table 1 provides the model-predicted 100-year floodplain elevations for the existing and proposed conditions, rounded to the nearest 0.001 foot. As shown, the proposed project does not increase the existing 100-year floodplain elevations.

Table 1: 100-year Floodplain Elevations for the Willamette River, RM 0.38 to RM 7.68

Cross-Section (RM)	100-year Floodplain Elevations (ft NGVD)		Difference (ft)
	Existing Condition	Proposed Condition	(Proposed – Existing)
0.38	25.900	25.900	0.000
1.52	26.039	26.039	0.000
2.4	26.107	26.107	0.000
3.03	26.109	26.109	0.000
3.5	26.087	26.087	0.000
4.25	26.205	26.205	0.000
4.26	26.206	26.206	0.000
4.27	26.210	26.209	-0.001
4.34	26.212	26.212	0.000
4.43	26.225	26.221	-0.004
4.54	26.224	26.223	-0.001
4.6	26.212	26.210	-0.002
4.68	26.243	26.242	-0.001
4.74	26.241	26.239	-0.002
4.75	26.238	26.236	-0.002
4.8	26.240	26.239	-0.001
5.0	26.237	26.236	-0.001
6.0	26.321	26.320	-0.001
6.7	26.430	26.428	-0.002
6.94	26.533	26.531	-0.002
7	26.545	26.544	-0.001
7.07	26.607	26.606	-0.001
7.68	26.819	26.818	-0.001

100-year Floodway Results
Table 2 provides the model-predicted 100-year floodway elevations for the existing and proposed conditions, again rounded to the nearest 0.001 foot. For the preliminary CDF design provided, the proposed project does not increase the existing 100-year floodway elevations, thus fulfilling FEMA's 'no-rise' criteria.

Table 2: 100-year Floodway Elevations for the Willamette River, RM 0.38 to RM 7.68

Cross-Section (RM)	100-year Floodway Elevations (ft NGVD)		Difference (ft)
	Existing Condition	Proposed Condition	(Proposed – Existing)
0.38	26.700	26.700	0.000
1.52	26.841	26.841	0.000
2.4	26.907	26.907	0.000
3.03	26.909	26.909	0.000
3.5	26.886	26.886	0.000
4.25	26.988	26.988	0.000
4.26	26.988	26.988	0.000
4.27	26.989	26.989	0.000
4.34	26.990	26.990	0.000
4.43	26.995	26.995	0.000
4.54	27.003	27.003	0.000
4.6	26.984	26.984	0.000
4.68	27.016	27.016	0.000
4.74	27.018	27.017	-0.001
4.75	27.018	27.018	0.000
4.8	27.028	27.028	0.000
5.0	27.031	27.031	0.000
6.0	27.108	27.109	-0.001
6.7	27.222	27.222	0.000
6.94	27.295	27.295	0.000
7	27.307	27.307	0.000
7.07	27.384	27.384	0.000
7.68	27.598	27.598	0.000

Results
In compliance with FEMA's 'no-rise' criteria, the HEC-RAS model results indicate that the proposed CDF and capping sites do not increase the 100-year floodplain or floodway elevations at any location relative to the existing condition.

The impacts of sedimentation, erosion and debris were not considered in the hydraulic analysis performed, in accordance with FEMA criteria. Sedimentation and erosion can modify the channel geometry of the waterway and possibly affect the model-predicted flood elevations. In addition, the hydraulic analysis addressed only the potential impacts of the proposed CDF to flood elevations and did not consider the issues of slope stability, bankline protection, scour or other geotechnical matters.

Please call me if you have any questions or if I can be of further assistance to you.

Best regards,

Cynthia Lowe, PE
PB Ports and Marine
Parsons Brinckerhoff Quade & Douglas, Inc.

Legend:
- Monitored Natural Recovery
- Cap
- Dredge to Specified Elevation
- Confined Disposal Facility

Slip 1 - Proposed CDF Location

Port of Portland Terminal 4

Wheeler Bay

Floodway Boundary

Berth 401

Cross-section Line

500-year Floodplain Boundary

100-year Floodplain Boundary

N Unnamed Road

Slip 3

Willamette River

WILLAMETTE

100-year Flood Elevation (feet)

ZONE AE

ZONE X

4.25
4.26
4.27
4.34
4.43
4.54
4.6
4.68
4.74
4.75
4.8

5.0

Floodway Boundary

FEMA FIRM Panel 4101830060E, dated October 19, 2004
hydrographic contours and conceptual design features provided by
Masland, Bouck & Lee

NW ST HELENS RD

Figure 1: Hydraulic Model
Cross-section Locations
Proposed CDF in Slip 1
Port of Portland Terminal 4
Willamette River

Attachment K-2

Technical Memo by Parsons Brinckerhoff on Floodway and Flood Storage Technical Explanation and Analysis

Memorandum

To: Anne Summers, Port of Portland

From: Cynthia Lowe, PE and Karl Krcma, PE

Date: May 2, 2005

Subject: Floodway and Flood Storage Technical Explanation and Analysis

I.   Introduction

The Port of Portland (Port) is required to perform a removal action at Terminal 4, which is located within the Initial Study Area of the Portland Harbor Superfund Site near River Mile (RM) 4.5 on the east bank of the Willamette River. The Port prepared a draft Engineering Evaluation/Cost Analysis (EE/CA) for the U.S. Environmental Protection Agency (EPA). In that report, the Port evaluates and ranks four alternative removal actions according to EPA criteria and guidance. One alternative, Alternative C, includes a confined disposal facility (CDF) in Slip 1, dredging of Slip 3, and capping at multiple locations, including a small area in the northeast corner of Berth 401, portions of the slope at Wheeler Bay, under the pier at Berth 411 and the nearshore slopes around Slip 3.

The purpose of this memorandum is to explain technical aspects of the Federal Emergency Management Agency (FEMA) flood hazard regulations in relation to the proposed removal action (Alternative C) at the Port's Terminal 4. Although FEMA does not regulate flood storage, the memorandum includes an analysis of potential flood storage impacts because EPA is required to evaluate the impacts to floodplains under other federal regulations (Executive Order 11988, Floodplain Management, May 24, 1977 and 40 C.F.R. Part 6, Appendix A). In response to your request, the memorandum also evaluates whether the removal action would have an impact on the community flood insurance rating and discount in the City of Portland.

II.   Floodway or Flood Rise Regulations

A.   National Flood Insurance Program

FEMA developed the National Flood Insurance Program (NFIP) for floodplain management and flood insurance purposes in the early 1970s. To implement the NFIP, FEMA prepares Flood Insurance Studies (FIS) for waterways across the United States, which provides communities with flood elevations and floodplain boundaries.

Floodplain/Floodway
The NFIP has adopted the 100-year flood as the national standard for floodplain management. For clarification, the 100-year flood is also termed the "base flood" or the one percent flood as the 100-year flood has a one percent chance of being equaled or exceeded in any year. In addition, the 100-year floodplain is defined as any land area susceptible to being inundated by water due to the base flood.

Recognizing the appeal of developing along waterways, FEMA developed the concept of a floodway as a floodplain management tool for communities. The floodway concept involves dividing the 100-year floodplain into two components: a floodway and a floodway fringe. The floodway represents the main channel of the waterway and any overbank area needed to convey the 100-year flood without causing an unacceptable increase to the 100-year flood elevations. The minimum Federal standard limits the allowable flood elevation increase to one foot above the 100-year flood elevation at any location along the waterway. Communities that adopt the FEMA floodway and participate in the NFIP must enforce FEMA regulations prohibiting placement of fill or structures within the floodway unless it can be shown that the proposed development does not increase the base flood elevation.

The floodway fringe represents the balance of the 100-year floodplain that does not lie within the floodway (Figure 1). The NFIP does allow fill to be placed within the floodway fringe, recognizing that the fill's impacts on flood elevations is managed through the floodway concept. Based on the definition of the floodway, the floodway fringe could be completely filled on both sides of a waterway and not increase the 100-year flood elevations by more than one foot at any location.

Figure 1.

Typical River Cross Section

100-year Floodplain

Floodway

Floodway Fringe   100 Year Flood Elevation   Floodway Fringe

River bottom
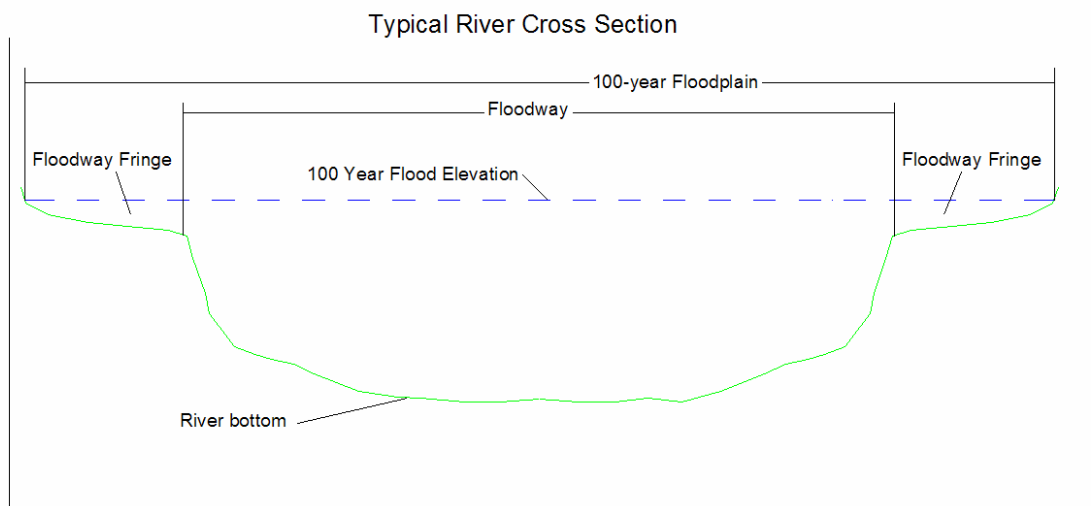
The floodway is typically calculated for FEMA flood studies using the U.S. Army Corps of Engineers Hydrologic Engineering Center computer programs HEC-2 and HEC-RAS. HEC-2 was developed in the mid 1970's and uses a standard-step backwater calculation to determine water surface profiles. HEC-RAS (River Analysis System) is an updated version of HEC-2 that incorporates, among other enhancements, a graphical user interface. Both programs are one-dimensional and model the geometry of the river by cross sections aligned perpendicular to the flow of the river. Water surface profiles are determined by interpolating between the model's cross sections.

FEMA Floodway Regulations
The following quote is taken directly from the FEMA NFIP Regulations for Floodplain Management and Flood Hazard Identifications, Code of Federal Regulations (CFR):

44CFR §60.3(d)(3) Prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge;

This regulation is commonly referred to as the "no rise" criteria. The intent of the regulation is to prevent any impedance to the conveyance of floodwaters within the floodway. By protecting the floodway and hence a waterway's conveyance, the "no rise" criteria provides upstream property owners with protection from increased floodway levels due to downstream development.

If the hydrologic and hydraulic analyses indicates an increase in flood levels due to the proposed encroachment in the floodway, provisions exist to still allow the development in the form of mitigation. Most commonly, the loss of conveyance due to the proposed development is mitigated by compensating actions to restore lost conveyance, such as dredging, reshaping the banks through grading, removing obstructions, or other reductions to improve the flow of floodwaters. One condition FEMA imposes for mitigating compensation is that it must be maintained for perpetuity.

Alternatively, FEMA has provisions for revising a floodway boundary via redelineation. The floodway revision process tends to be rather lengthy due to the public approval period, FEMA's technical review, and the hydraulic analysis required. Technically the floodway could be revised (narrowed) as long as the one foot flood elevation increase is not exceeded at any point along the waterway.

The City of Portland follows FEMA guidelines for controlling development in the floodplain, and the City has adopted ordinances which FEMA designed to reduce future flood losses. The City's flood plain management ordinance is found at PCC 24.50.060.D of the city's zoning ordinances. This ordinance follows the FEMA CFR in essence and provides the City a means to enforce the FEMA NFIP "no rise" regulation. The ordinances also fulfill a FEMA requirement to allow the community to purchase federal flood insurance through the NFIP.

C.   Application to Terminal 4 Removal Action

According to FEMA, no increase in the base flood elevation can result due to placement of fill or placement of structures within a floodway. Consequently, if the CDF or sediment caps are placed within the floodway boundary, this would require an analysis to demonstrate that the encroachment into the floodway will not increase the base flood elevation.

Two of the three cap placements proposed encroach into the floodway. For the two floodway encroachments, one cap is located near the downstream end of Berth 401 and the other near the upstream end of Slip 3. Based on the conceptual design, only around 2,000 square feet of cap placement intrudes into the floodway at Berth 401 and approximately 470 square feet near Slip 3. A HEC-RAS model was used to analyze the proposed cap placements. The HEC-RAS modeling results indicated no rise in the base flood elevations due to the proposed cap placements. This is documented in PB's letter to the Port dated March 11, 2005.

The proposed CDF in Slip 1 is in the floodway fringe, but outside of the floodway limits. Therefore, according to FEMA regulations, the fill is allowable. The fill also meets the requirements of City of Portland floodway ordinance (PCC 24.50.060.D). Even though the CDF does not encroach within the floodway, a HEC-RAS analysis was still performed to assure that the CDF would not cause a rise in the base flood elevations. The results of the analysis indicated that no rise resulted from filling the slip based on the conceptual design. This is also documented in PB's letter to the Port dated March 11, 2005.

## III.   Flood Storage Evaluation

Although FEMA does not have a regulation regulating flood storage, EPA is required to evaluate the impacts to floodplains under other federal regulations (Executive Order 11988, Floodplain Management, May 24, 1977 and 40 C.F.R. Part 6, Appendix A). Evaluation of flood storage is important to ensure that the quantity of water reaching the watercourse (and ultimately downstream property) is not increased. An analysis of flood storage impacts was conducted to ensure that the removal action will not increase flood hazards to downstream property owners.

A.   Flood Storage

Flood storage refers to the temporary filling of overflow areas or retention/delay of runoff during a flood event. Typically a rainfall storm event occurs such that the rainfall runs overland, after saturating the ground, and eventually into a stream. If the overland flow is high enough or takes place over a long enough period of time, the capacity of the stream is exceeded. Floodwaters that spill out of the stream's banks flow into overflow (floodplain) areas. The water that is spilled into the overbank areas is temporarily "stored", thus reducing the quantity of flow downstream in the main channel of the stream. As the flood recedes, the overland areas drain back into the stream.

The area available for flood storage is the area above the stream level just preceding the storm event, termed the non-storm winter stage, up to the 100-year flood elevation, as shown in Figure 2. Because the area below the non-storm winter stage is already inundated when the storm event occurs, it provides no flood storage during a storm event.

Figure 2.
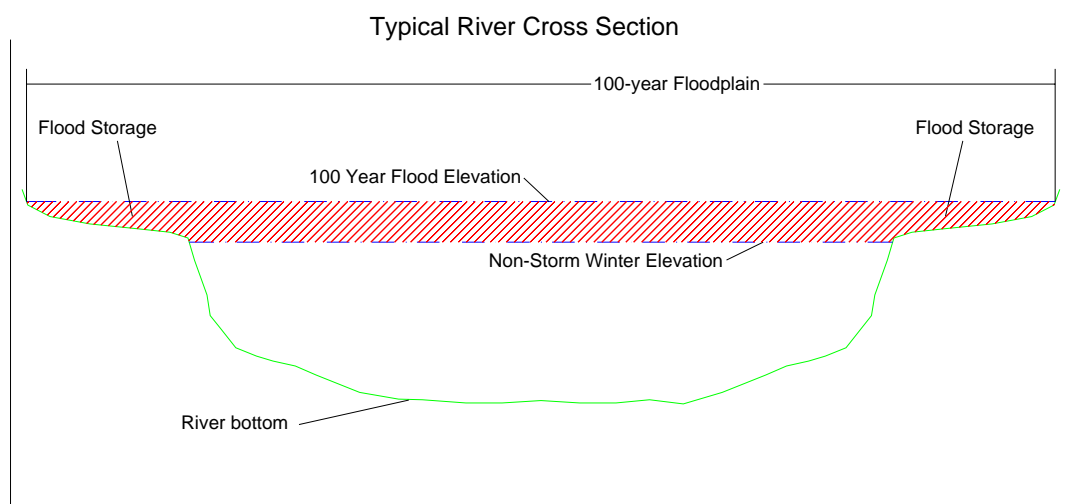
An example to compare the effects of flood storage is the difference between typical streams in rural versus urban settings. The rural stream would typically have more overland storage due to less development of the floodway fringe areas, resulting in some floodwaters temporarily held in the overbank areas. However, the typical urban stream would have less storage due to floodway fringe development, which would confine the floodwaters to the main channel, resulting in a quicker rise of water surface and a greater peak discharge. In summary, the flood event without storage rises quicker and would have a slightly greater peak discharge than a flood event on a stream with greater flood storage.

The effectiveness of the flood storage, however, is not the same for every stream. The effectiveness depends upon the size of the drainage basin, the amount of storage, the location of the storage, characteristics and timing of the design storm event, and characteristics of the riverine hydraulics. For example, Johnson Creek in the Portland Metro area has a drainage basin of 54 square miles. The 100-year flood event on Johnson Creek has a peak discharge of 2,780 cubic feet per second (cfs) and the flood generally takes place over 24 hours or less. The drainage basin of the Willamette River is 11,600 square miles with a 100-year peak discharge of 375,000 cfs and a duration of the flood event occurring over 2 days or more. An effective overbank flood storage volume of 300,000 cubic yards (cyd) would have the effect of reducing the time of flooding on Johnson creek 48 minutes versus 22 seconds on the Willamette River. A 300,000 cyd flood storage volume would probably provide a noticeable difference to the peak discharge and consequently reduced flood impacts downstream on Johnson Creek; however, the same volume would not provide a noticeable difference to peak discharge or downstream impacts on the Willamette River.

B.   Evaluation of Terminal 4 Removal Action

CDF
A portion of the CDF will be located above the non-storm winter stage and some flood storage will be lost by placement of the CDF. However, the lost flood storage from filling Slip 1 has an insignificant effect in reducing flood hazard due to the relative size of the Columbia and Willamette River drainage basins, the location of Terminal 4, the amount of storage provided by Slip 1 relative to the drainage basin, the duration of the flood events on the Willamette River, and the riverine hydraulics.

Terminal 4 is located near the outlet of the Willamette River drainage basin. The drainage basin of the Willamette River is 11,600 square miles with a 100-year peak discharge of 375,000 cfs and a duration of the flood event occurring over two days or more. In addition, the hydraulics of the lower Willamette River is impacted by backwater effects from the Columbia River which encompasses an even larger drainage basin than the Willamette River.

The regulatory 100-year flood elevation on the Willamette River is computed by analyzing river stage statistics for the Portland harbor and the Columbia River. Two types of flooding can impact Portland harbor:
   1) Willamette River floods that usually occur in winter months (around November through February) and
   2) Columbia River floods that usually occur during spring freshet (May through July).

The drainage basin of the Columbia River above the confluence with the Willamette River is approximately 241,000 square miles, and the modeled 100-

year discharge is 565,000 cfs. Since the 100-year elevation is computed on stage statistics, the discharge for purposes of modeling a floodway on the Willamette and Columbia Rivers is determined by modeling various flows until the statistically determined stage is achieved. The dominating elevation for the 100-year flood in the vicinity of Terminal 4 is actually the backwater from the Columbia River flood.

The volume of potential flood storage that would be lost as a result of the CDF construction was calculated. Digital bathymetry and topographic information supplied by BB&L, Inc. was utilized to develop a digital terrain model of the site. For purposes of comparison, two volumes were computed:
1) the difference between the 100-year flood elevation and ordinary high water (OHW) representing the bank full stage, and
2) the difference between the 100-year flood and the 50% exceedance (high tide) stage for Portland harbor, representing an "average" river stage.

Table 1 lists the results for the two volumes and includes the time required to fill the storage volume during the 100-year flood event. The previously stated 100-year discharge for the Willamette River in the T-4 reach of 375,000 cfs was used to calculate the fill time. In order to provide a more conservative estimate, a Willamette River flood without influence from Columbia River backwater effects was assumed.

Table 1. T-4 CDF Flood Storage Calculations		
Description	Volume (cyds)	Time to fill (seconds)
OHW to 100-year	265,700	19
50% exceedance to 100-year	458,000	33

Using the Johnson Creek example as a comparison, assume that 458,000 cyds of flood storage is lost. That would equate to 1.24 hours of storage on Johnson Creek for a flood that takes place over 24 hours or less versus 33 seconds on the Willamette River by Terminal 4 for a flood that lasts two days or more. On Johnson Creek the storage would probably be effective in reducing downstream peak flows; however, on the Willamette River at this location, the flood storage of 458,000 cyds is insignificant and would result in no noticeable increase in peak discharge.

This conclusion is further highlighted by comparing the flood storage at Slip 1 to the flood storage of the overall system. Since the 1930's, Federal and private dams have been built in the Willamette and Columbia River drainage basins to store water for flood control, generate hydroelectric power, and for other purposes. There are 32 major reservoir projects operated by the Corps of Engineers, in addition to 45 other non-federal projects including three Canadian

reservoirs. The combined flood storage of the system exceeds 39 million acre-feet of storage. A storage volume of 458,000 cyds equals approximately 284 acre-feet. Compared to upstream flood control storage projects, the 284 acre-feet is only 0.00073% of the total storage (39 million acre-feet). Consequently, the loss of flood storage at Terminal 4 would not have a noticeable impact downstream.

Based on these factors, Slip 1 provides insignificant effective flood storage at this location on the Willamette River and the loss of flood storage from the CDF would not have a noticeable impact downstream.

Capping
Capping is proposed at multiple locations in T-4 including a small area in the northeast corner of Berth 401, portions of the slope at Wheeler Bay, under the pier at Berth 411 and the nearshore slopes around Slip 3. Based on information from BBL, the preliminary capping thickness is three feet at Berth 401 and Wheeler Bay and three to four feet at Slip 3. From a technical standpoint. no flood storage would be lost because the cap as proposed will be placed below the non-storm winter stage. In other words, because the location of the proposed cap is already inundated before the floodwaters arrive, no storage would be lost by placement of a cap, and consequently no impact on flood storage would occur.

C.   Portland's Flood Insurance

While FEMA does not have a flood storage regulation, FEMA has a Community Rating System (CRS) as a part of the NFIP that credits communities for various floodplain management criteria. The City of Portland receives some credit for flood storage protection through the CRS. In response to your request an evaluation considered whether removal of the flood storage at Slip 1 would have an impact on the City of Portland's flood insurance rating and discount.

The CRC implements a point system that awards points based on a total of 18 floodplain management activities which are organized under four general areas: 1) public information, 2) mapping and regulations, 3) flood damage reduction, and 4) flood preparedness. The point system determines the class rating and discount applicable in the community. The City of Portland is rated as a Class 6 CRS community and receives a 20% discount on flood insurance due to their rating.

Some criteria for Portland's CRS rating include but are not limited to: having a requirement that homes are elevated a minimum of one foot above the base flood elevation, providing open space along waterways, participating in a repetitive loss program, and having a balanced cut and fill ordinance (PCC 24.50.060.F.8). The Class 6 rating requires a total of 2,000 to 2,499 points, of

which a provision for compensating storage awards up to 70 points. According to FEMA's last verification, the City of Portland has a total of 2,194 points in the CRS rating. Of the 2,194 points, the City received 28.7 points for the balanced cut and fill requirement in PCC 24.50.060.F.8. Even if the removal of the flood storage at Terminal 4 caused the NFIP to take away the City's points for this category, which is not likely, the City of Portland would retain its Class 6 rating.

IV. Conclusions

As modeled using HEC-RAS, the proposed caps and CDF at Terminal 4 result in no increase to base flood elevations, thus fulfilling FEMA regulations and the City of Portland 24.50.060 provisions for flood hazard reduction.

The caps are proposed to be placed below the OHW water level; therefore, the capping would not remove any flood storage from the Willamette River basin..

The proposed CDF does remove flood storage, however, due to the insignificant volume compared to the Columbia/Willamette drainage basins, no noticeable impact to flooding in the Willamette River would occur as a result of the CDF.

REFERENCES

Atkinson, Denise, E-mail correspondence with Cynthia Lowe re City of Portland CRS Questions, March 15, 2005

City of Portland, Code and Charter, Title 24 Building Regulations, Chapter 24.50 Flood Hazard Areas, February 4, 2005

Code of Federal Regulations, Title 44, Emergency Management and Assistance, Revised October 1, 2004

Executive Order 11988, Floodplain Management, May 24, 1977 and Code of Federal Regulations, Title 40, Part 6, Appendix A

Federal Emergency Management Agency, Flood Insurance Study, City of Portland, Oregon, Revised October 19, 2004

Metro, Title 3 Model Ordinance, Growth Management Committee, May 28, 1998

U.S. Army Corps of Engineers, February 1996 Postflood Report, Hydrometerorological Evaluation, September 1997

U.S. Geological Survey, Water-Data Report OR-03-1, Water Resources Data Oregon Water Year 2003, June 2004

Attachment K-3

Surface Water Quality Screening Values Based on Tribal Fish Consumption Rates

BBL ®
BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

Attachment K-3 – Surface Water Quality Screening Values Based on Tribal Fish Consumption Rates

The following table is provided at request of USEPA and the Tribes. The table was supplied by the Tribes.

| | HHSV (ug/L) | |
Analyte	Fish and Water Consumption	Fish Consumption Only
Metals		
Arsenic	4.12E-03	5.19E-03
Antimony	5.15E+00	6.40E+01
Copper	1.30E+03	
Nickel	1.37E+02	1.70E+02
Selenium	1.23E+02	4.17E+02
Zinc	2.05E+03	2.55E+03
PCBs		
PCB Aroclors*	6.41E-06	6.41E-06
Organochlorine Pesticides		
a-BHC	4.49E-04	4.88E-04
b-BHC	1.57E-03	1.71E-03
g-BHC (Lindane)	2.18E-03	2.37E-03
Heptachlor	7.93E-06	7.94E-06
Aldrin	5.03E-06	5.04E-06
Heptachlor Epoxide	3.92E-06	3.92E-06
Chlordane	8.10E-05	8.11E-05
Endosulfan	8.53E+00	8.89E+00
4,4'-DDE	2.19E-05	2.19E-05
Dieldrin	5.34E-06	5.35E-06
Endrin	6.03E-03	6.05E-03
4,4'-DDD	3.11E-05	3.11E-05
Endrin Aldehyde	3.01E-02	3.02E-02
4,4'-DDT	2.19E-05	2.19E-05
Methoxychlor	1.00E+02	
Hexachlorobenzene	2.87E-05	2.88E-05
Toxaphene	2.77E-05	2.78E-05
Hexachlorobutadiene	3.61E-01	1.84E+00
Halogenated SVOCs		
1,2-Dichlorobenzene	1.07E+02	1.29E+02
1,3-Dichlorobenzene	8.00E+01	9.64E+01
1,4-Dichlorobenzene	1.60E+01	1.93E+01
1,2,4-Trichlorobenzene	6.38E+00	7.02E+00
Hexachlorobenzene	2.87E-05	2.88E-05
2-Chloronaphthalene	1.50E+02	1.58E+02
Hexachlorobenzene	2.91E-01	3.29E-01
Hexachlorobutadiene	3.61E-01	1.84E+00
Hexachlorocyclopentadiene	3.04E+01	1.11E+02
Bis-(2-chloroethyl) ether	1.98E-02	5.27E-02
3,3'-Dichlorobenzidine	2.75E-03	2.85E-03

	HHSV (ug/L)	
Analyte	**Fish and Water Consumption**	**Fish Consumption Only**
Organonitrogen SVOCs		
Nitrobenzene	1.40E+01	6.92E+01
N-Nitrosodimethylamine	6.85E-04	3.02E-01
N-Nitroso-di-n-propylamine	4.55E-03	5.06E-02
N-Nitrosodiphenylamine	5.54E-01	6.00E-01
2,4-Dinitrotoluene	8.45E-02	3.38E-01
Oxygen-Containing SVOCs		
Isophorone	2.66E+01	9.61E+01
Phenols and Substituted Phenols		
Phenol	1.87E+04	1.71E+05
2,4-Dimethylphenol	7.60E+01	8.53E+01
2-Chlorophenol	1.38E+01	1.49E+01
2,4-Dichlorophenol	2.30E+01	2.95E+01
2,4,5-Trichlorophenol	3.29E+02	3.64E+02
2,4,6-Trichlorophenol	2.25E-01	2.42E-01
Pentachlorophenol	1.49E-01	3.03E-01
2,4-Dinitrophenol	6.19E+01	5.33E+02
4,6-Dinitro-2-methylphenol	9.22E+00	2.84E+01
Phthalate Esters		
Dimethylphthalate	8.43E+04	1.11E+05
Diethylphthalate	3.79E+03	4.38E+03
Di-n-butylphthalate	3.98E+02	4.49E+02
Butylbenzylphthalate	1.88E+02	1.93E+02
bis(2-Ethylhexyl)phthalate	2.02E-01	2.20E-01
Polycyclic Aromatic Hydrocarbons		
Acenaphthene	9.47E+01	9.92E+01
Fluorene	3.86E+02	5.33E+02
Anthracene	2.90E+03	4.00E+03
Fluoranthene	1.38E+01	1.39E+01
Pyrene	2.90E+02	4.00E+02
Benzo(a)anthracene	1.32E-03	1.83E-03
Chrysene	1.32E-03	1.83E-03
Benzo(b)fluoranthene	1.32E-03	1.83E-03
Benzo(k)fluoranthene	1.32E-03	1.83E-03
Benzo(a)pyrene	1.32E-03	1.83E-03
Indeno(1,2,3-cd)pyrene	1.32E-03	1.83E-03
Dibenz(a,h)anthracene	1.32E-03	1.83E-03
Chlorinated Dioxins and Furans		
2,3,7,8-TCDD	5.12E-10	5.13E-10

*HHSV is the same for each Aroclor and for total PCBs.